All India Institute of Medical Sciences
NEW DELHI

Guidance document on

Preparedness for Infection Prevention and Control including Biomedical Waste Management during Public Health Emergencies

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All India Institute of Medical Sciences

New Delhi

Guidance document on

Preparedness for Infection Prevention and Control including Biomedical Waste Management during Public Health Emergencies

For Healthcare Workers in Secondary and Tertiary Healthcare Facilities for Preparedness on Infection Prevention & Control including Biomedical Waste Management during Public Health Emergencies

USAID FROM THE AMERICAN PEOPLE

RISE Reaching Impact, Saturation, and Epidemic Control

NHSRC

Published by All India Institute of Medical Sciences under a National Capacity Building Programme on Infection Prevention and Control including Biomedical Waste Management carried out by Department of Hospital Administration, AIIMS, New Delhi under USAID RISE initiative for COVID-19.

Message

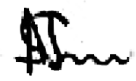
In a nation as diverse and vast as ours, with a plethora of healthcare challenges, a standardized Guidance document on Infection Prevention and Control including Biomedical Waste Management for public health emergencies is crucial. It empowers the healthcare professionals, with the necessary knowledge and skills to provide top-quality medical care. By doing so, we not only raise the bar for healthcare delivery but also enhance the overall health and well-being of our citizens.

I firmly believe that this Guidance document, as envisioned and meticulously executed, will play a pivotal role in bolstering capacity building and standardizing practices within secondary and tertiary healthcare facilities. Its successful completion represents a vital step towards ensuring that our healthcare professionals have access to the latest knowledge and best practices, thereby improving patient care and safety nationwide.

I extend my sincere gratitude to the Expert Advisory Group and the Project Team for their outstanding contributions. I am confident that this accomplishment is only the beginning of many more remarkable achievements to come.

I believe that this Guidance document will serve as a source of knowledge for generations of healthcare professionals, making a significant impact on healthcare delivery in our country.

Warm regards,



Prof. (Dr.) M. Srinivas
Director
All India Institute of Medical Sciences,
New Delhi

Message

In an era where infectious diseases demand heightened awareness and proactive prevention, I am humbled to emphasize the integral role of infection control 'In preserving the well-being of our communities'. A well-managed healthcare system not only safeguards patients but also contributes significantly to the overall health and resilience of our society.

As stewards of the environment, we understand the critical importance of effective waste management, particularly in handling hazardous biomedical waste. This responsibility is not only vital for preserving ecological balance but also paramount in safeguarding public health.

The realms of infection control and biomedical waste management, traditionally associated with healthcare, now intersect profoundly with environmental concerns. These areas also hold farreaching implications for our progress towards the Sustainable Development Goals (SDGs). Embracing best practices. These domains allows us to make significant strides in achieving key SDGs related to health and well-being (SDG 3), clean water and sanitation (SDG 6), responsible consumption and production (SDG 12), and life on land and below water (SDGs 14 and 15).

I am thrilled to introduce this Learning Resource Package that delves into the critical domains of Infection Control and Biomedical Waste Management. My commendations go to the collective effort of healthcare experts who have collaborated to produce this invaluable resource. Special appreciation is extended to those who have dedicated their time to its development. The interdisciplinary approach exemplifies the power of partnerships in addressing challenges that transcend traditional boundaries.

I urge everyone, from healthcare professionals to policymakers, to embrace this resource as a bridge between our fields. By fostering a deeper understanding of the interplay between healthcare and the environment, we can collectively develop holistic and sustainable solutions for the well-being of our communities.

In conclusion, let us seize this exciting opportunity to enhance our collective knowledge and contribute to a healthier, more sustainable future for all.

Executive Director
Maj Gen (Prof) Atul Kotwal
NHSRC, MoHFW, Gov. of India

Message

The U.S. government, through the United States Agency for International Development (USAID) closely collaborates with the Government of India to advance global health security. Our collaboration builds on more than 70 years of partnership and cooperation in the public health, biomedical, and behavioral health science fields in India.

The collaboration between USAID, Jhpiego, and the All India Institute of Medical Science (AIIMS) New Delhi, signifies a dynamic alliance committed to bolstering health systems' abilities to prepare for and respond to public health threats, with a focus on improving infection prevention and control, and biomedical waste management. This partnership underscores USAID's shared commitment to prepare health systems across the globe for future outbreaks by equipping health workers, institutions, and communities with invaluable strategies and practices.

The Biomedical Waste Management and Infection Prevention and Control Learning Resource Package highlights evidence-based practices from the forefront of biomedical and behavioral sciences. It aims to improve competencies in safe infection prevention practices and biomedical waste management, and explores less-discussed factors in pandemic management. This resource departs from traditional approaches by incorporating insights from behavioral economics, human-centered design, and behavior change communications. It advocates for evidence-driven strategies that not only save lives, but also foster adaptable and resilient societies. The guidance released today will further our goals by equipping healthcare workers with the latest tools and technologies to better manage biomedical waste and respond to public health emergencies.

Thanking You,

Michelle Lang-Alli

Michelle M. Lang-Alli
Director, Office of Health, USAID/India

Message

It is understood that with the growing concern over Infection Control and Biomedical Waste Management, the need for a comprehensive guide to pandemic preparedness is more pressing than ever. The objective of this Learning Resource Package is to provide a comprehensive and single source of information for all healthcare workers, on all the aspects of Infection Control Practices including Biomedical Waste Management during any future pervasive medical situations.

It gives me great pleasure to thank Sh. Vishal Chauhan, IAS, Joint Secretary (Health Policy), Ministry of Health & Family Welfare, Govt of India who has kindly chaired the Expert Advisory Group meetings and Dr. J.N. Shrivastava who was a co-chair. I thank you for your support and contribution to the project by providing your valued inputs and time.

It is essential to acknowledge and express gratitude to the subject experts who have made significant contributions, particularly clinicians, microbiologists, and hospital administrators across the country. The Expert Advisory Group has worked diligently to ensure that the information provided in this LRP is extracted from the latest guidelines and from evidence-based research materials. The entire project team has been instrumental in the creation as their attention to detail and dedication to perfection have contributed to the polished and professional nature of the final output.

Dr. D. K. Sharma
Medical Superintendant
Dr Rajendra Prasad Centre for Ophthalmic Sciences,
AIIMS, New Delhi
and Co-Chairperson, Expert Advisory Group

Message

NHSRC remains committed to support the States in improving the Quality of care (QoC) delivered at the public health facilities. In this endeavour, many interventions such as implementation of National Quality Assurance Standards (NQAS), Kayakalp and meeting the requirements under the Biomedical Waste Rule at Primary and Secondary Health Facilities have been supported under the National Health Mission.

Learning from the global best practices and implementation of proper Infection Prevention Protocols would go a long way in reducing Healthcare associated infections (HAI) and getting improved health outcomes. I am sanguine that this Learning Resource Package on Infection Prevention and Control including Biomedical Waste Management under this initiative will play a significant role in meeting the pressing need for standardizing practices all over the country.

The journey of compiling this LRP has been a challenging at the same time a rewarding one. I would like to extend my heartfelt thanks to Sh. Vishal Chauhan, IAS Joint Secretary (Policy) MOHFW and Chairperson of the Expert Advisory Group for his constant support and guidance throughout this project. It has been an indeed a great honor to work alongside him. I would also like to express my sincere gratitude to all the subject experts who have contributed their time and expertise to make this Learning Resource Package a comprehensive guidance document on Infection Prevention and Control including biomedical waste management for public health emergencies. Your contributions have been invaluable.

Lastly, I would urge all states and UTs to start using the resource material under the package for strengthening of infection control practices in the Public Health System.

Dr. J N Srivastava
Senior Advisor, Quality and Patient Safety, NHSRC
& Co-Chairperson, Expert Advisory Group

Message

I am happy to be presenting this important technical learning resource centering on Infection Prevention and Control (IPC) and Biomedical Waste (BMW) management in the context of pandemic readiness.

Embedded in this compendium are narratives highlighting the impactful endeavors led by the All India Institute of Medical Sciences New Delhi, National Health Systems Resource Centre, and the USAID-funded, Jhpiego-led Reaching Impact, Saturation & Epidemic Control (RISE) project. We hope these insights and strategies serve as a guiding light for future interventions, significantly contributing to adopting sustainable and evidence-based practices in the crucial domain of infection prevention and control, encompassing biomedical waste management. The resource package will serve as a practical guide for healthcare facilities, ensuring the implementation of best practices in infection control and biohazardous waste management.

The development of an evidence-based resource package for IPC and BMW was deemed essential during the pandemic to support healthcare organizations in implementing effective infection control measures and safe biohazardous waste management. The USAID, Jhpiego, and the All-India Institute of Medical Science (AIIMS) New Delhi partnered to enhance the capacities of health systems as a preparedness and response to the pandemic and future similar emerging infectious disease threats.

By providing comprehensive guidelines, educational materials, and training modules, this resource package aims to enhance knowledge, promote best practices, and ultimately contribute to improved patient safety, reduced healthcare-associated infections, and a healthier environment.

The released guidance documents will advance our objectives by providing healthcare workers with up-to-date tools and technologies, enhancing their ability to effectively manage biomedical waste and respond to public health emergencies.

Thank you.

Somesh Kumar

Dr. Somesh Kumar
Country Director, Jhpiego-India

Acknowledgement

Our journey with this Learning Resource Package began as a mere seedling of an idea, and it evolved and transformed countless times before reaching its present form. The Learning Resource Package that now stands before you is not just a culmination of efforts; it is a testament to the power of collaboration, dedication, and the unwavering support of an exceptional Group of Experts, Contributors, Technical Partners and Project Team.

At the outset, I wish to express my profound gratitude to the Chair of the expert Advisory Group, Sh. Vishal Chauhan sir, for his exceptional leadership as the Chair of our Expert Advisory Group meetings. Your contributions have made a significant difference, and we are fortunate to have you as our Chair. We look forward to continuing to benefit from your guidance and expertise as we move forward.

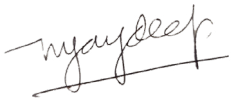
I want to like to thank the Co-Chair of the Expert Advisory Group; Dr. J.N. Srivastava, whose ability to collaborate, provide guidance, and foster a productive environment within the group has been a significant support. I would also like to extend my sincere gratitude Co-Chair, Dr. D.K Sharma for being a source of inspiration and a pillar of unwavering support throughout. Your mentorship has enriched and made this Learning Resource Package theoretically sound and ready to effectively address real-world challenges and needs.

To all the Experts who generously shared their wisdom, insights, and expertise; in a world where time is the most precious commodity, your willingness to set aside your busy schedule for this project is an act of unparalleled magnanimity. Each of you has been a guiding light, illuminating the path, and I feel privileged to be the Member Secretary of the Expert Advisory Group that has been crucial in developing this Learning Resource Package.

To the project team who have transformed ideas into a tangible reality, your creativity, dedication, and relentless pursuit of excellence have not only shaped this project but have also transformed it into a beacon of knowledge and inspiration. We extend our heartfelt gratitude to USAID RISE and Jhpiego for their unwavering support for the project. Their commitment and generosity have been instrumental in helping us make a meaningful impact with this resource.

I would also like to extend my sincere appreciation to my alma mater, Department of Hospital Administration, AIIMS New Delhi and the locus where this Learning Resource Package was forged to shape for being an invaluable resource of illustrations, information, and expertise. I would like to specially thank the entire team of Hospital Infection Control at AIIMS Hospital New Delhi for designing and carrying out the hands-on training module in Infection Control and Biomedical Waste management. Special thanks to the Project Team at AIIMS New Delhi for their immense contribution to this endeavour. With this resource, we hope to empower Healthcare Workers to stimulate their skills and refine their practices to better standards.

I would like to express my profound gratitude to one and all who have been associated this endeavour directly or indirectly.



Dr. Vijaydeep Siddharth
Additional Professor, Hospital Administration, AIIMS, New Delhi
Member Secretary, Expert Advisory Group & Project Lead

Expert Advisory Group

Sh. Vishal Chauhan, IAS

Joint Secretary (Health Policy), Ministry of Health and Family Welfare, Govt. of India & Chairperson, Expert Advisory Group (EAG)

Dr. D. K. Sharma

Medical Superintendent
Dr. R P Centre for Ophthalmic Sciences, AIIMS, New Delhi &
Co-Chairperson, EAG

Dr. Vipin Kaushal

Medical Superintendent,
Professor & Head,
Dept. of Hospital Administration,
PGIMER, Chandigarh.

Dr. Rakesh Lodha

Professor,
Dept. of Paediatrics,
AIIMS, New Delhi.

Prof. Sidhartha Satpathy

Professor & Head,
Dept. of Hospital Administration,
AIIMS, New Delhi.

Dr. Gagandeep Singh

Additional Professor,
Dept. of Microbiology
AIIMS, New Delhi.

Dr. J. N. Srivastava

Advisor, Quality & Patient Safety,
NHSRC, MoHFW &
Co-Chairperson, EAG

Dr. Vijaydeep Siddharth

Additional Professor,
Dept. of Hospital Administration,
AIIMS, New Delhi &
Member Secretary, EAG

Lt. Gen. Sunil Kant

Former Director General,
Hospital Services (Armed Forces) and 'Colonel Commandant' of Army Medical Corps and Medical Superintendent, AIIMS, Jammu.

Dr. Arti Kapil

Professor,
Dept. of Microbiology,
North DMC Medical College &
Hindu Rao Hospital, New Delhi

Dr. Purva Mathur

Professor,
Dept. of Laboratory Medicine,
Jai Prakash Narayan Apex Trauma Center (JPNATC),
AIIMS, New Delhi.

Dr. Hitender Gautam

Additional Professor,
Dept. of Microbiology
AIIMS, New Delhi.

Dr. Somesh Kumar

Country Director -
Jhpiego India

Mr. Vijay Paulraj

Senior Health System
Strengthening Advisor,
USAID India.

Dr. Vineet Kumar Srivastava

Senior Program Director, &
Chief of Party
Jhpiego-USAID RISE.

Dr. Prem Singh

Associate Director &
Deputy Chief of Party,
Jhpiego-USAID RISE.

Dr. Sanjeev K. Singh

Medical Director,
Amrita Institute of Medical
Sciences and Research Centre,
New Delhi.

Dr. Parmeshwar Kumar

Additional Professor,
Dept. of Hospital Administration,
AIIMS, New Delhi.

Dr. Vikas Manchanda

Professor,
Dept. of Microbiology, Maulana
Azad Medical College, New
Delhi

Dr. Desu Rama Mohan

Professor and Head,
Dept. of Hospital
Administration, AIIMS,
Mangalagiri

Dr. Sunite A Ganju

Professor & Head,
Dept. of Microbiology, Shri Lal
Bahadur Shastri Govt Medical
College, Mandi

Dr. Raman Sardana,

Secretary, Hospital Infection
Control Society-India &
Professor, Clinical Microbiology,
Apollo Hospitals, Delhi

Dr. Leena Mehndiratta

Senior Consultant,
Microbiology,
Apollo Hospitals.

Prof. Joy S Michael

Professor,
Clinical Microbiology, CMC,
Vellore.

Dr. Aarti Tewari

Joint Director (Microbiology),
National Centre for Disease
Control (NCDC), Delhi.

Dr. Abdul Hakim

Associate Professor,
Dept. of Hospital Administration,
AIIMS, New Delhi.

Dr. Manoj Jais

Professor & Head,
Deptt. of Microbiology, Lady Hardinge Medical College,
New Delhi.

Dr. Manisha Biswal

Professor,
Dept. of Microbiology PGIMER,
Chandigarh.

Dr. Mede Charan Raj

Assistant Professor,
Dept. of Hospital Administration,
AIIMS, New Delhi.

Dr. Narinder Kumar

Assistant Professor,
Dept. of Hospital Administration,
AIIMS, Rishikesh.

Dr. Dewesh Kumar

Professor,
Dept. of PSM, Rajendra Institute of Medical Sciences,
Ranchi

Dr. Laxmitej Wundavalli

Assistant Professor,
Dept. of Hospital Administration,
NCI-AIIMS, Jhajjar

Dr. Parminder Gautam

National Professional Officer-Quality and Patient Safety,
WHO India Office

Dr. Birendra Singh

Nodal Officer- State Quality Cell Gujarat
(West Region)

Dr. Kulkarni Vaman

Assistant Professor,
Dept. of Community Medicine and Family Medicine,
AIIMS, Bibinagar.

Dr. Neeraj Nischal

Additional Professor,
Dept. of General Medicine,
AIIMS, New Delhi.

Ms. Kamlesh Chandelia

Chief Nursing Officer,
AIIMS, New Delhi.

Project Team

Dr. Paavan Gopathoti
Consultant,
Jhpiego-USAID RISE.

Dr. Tilotma Jamwal
Senior Resident,
Dept. of Hospital Administration,
AIIMS, New Delhi.

Dr. Kshitija Singh
Senior Resident,
Dept. of Hospital Administration,
AIIMS, New Delhi.

Dr. Megha Richhariya
Senior Resident,
Dept. of Hospital Administration,
AIIMS, New Delhi.

Dr. Ananth Naveen Kumar Reddy
Senior Resident,
Dept. of Hospital Administration,
AIIMS, New Delhi.

Dr. Kirti Garg
Consultant,
Jhpiego-USAID RISE.

Dr. Tony Joseph
Junior Resident
Dept. of Hospital Administration
AIIMS, New Delhi.

Dr. Ranjith Raam Kumarr. G
Junior Resident
Dept. of Hospital Administration
AIIMS, New Delhi.

Dr. Sara Alisha Khan
Consultant,
AIIMS

Mr. Anurag Verma
Technical Officer,
Jhpiego-USAID RISE.

Dr. Akansha Kumari
Consultant,
Jhpiego

Dr. Shalini Khare
Senior Program Officer,
Jhpiego-USAID RISE.

Infection Control Nursing Officers Team

Evangelin Vasanth
Hospital Infection Control Nursing Officers

Betty Maria Binu
Hospital Infection Control Nursing Officers

Kunj Bihari Gauttam
Hospital Infection Control Nursing Officers

Dhawal Dvivedi
Hospital Infection Control Nursing Officers

Sharmistha Banerjee
Hospital Infection Control Nursing Officers

Tsering Lamo
Hospital Infection Control Nursing Officers

Shivani
Hospital Infection Control Nursing Officers

Monika
Hospital Infection Control Nursing Officers

Savita Shokeen
Hospital Infection Control Nursing Officers

Ani Skariah
Hospital Infection Control Nursing Officers

Preeti Balyan
Hospital Infection Control Nursing Officers

Kanupriya
Hospital Infection Control Nursing Officers

Sweta Verma

Hospital Infection Control
Nursing Officers

Aswathi A K

Hospital Infection Control
Nursing Officers

Spandana Kapudasi

Hospital Infection Control
Nursing Officers

Mukesh Kumar

Hospital Infection Control
Nursing Officers

Table of Contents

Acronyms

ABHR	Alcohol-Based Hand Rub
AIDS	Acquired Immunodeficiency Syndrome
AMR	Antimicrobial Resistance
ARO	Antibiotic Resistant Organisms
BI	Biological Indicators
CAUTI	Catheter-Associated Urinary Tract Infection
CBWTF	Common Biomedical Waste Treatment Facility
CDC	Centers for Disease Control and Prevention
CDI	Clostridium Difficile Infection
CI	Chemical Indicators
CLABSI	Central Line-Associated Bloodstream Infection
COVID-19	Coronavirus Disease 2019
CoNS	Coagulase-Negative Staphylococcus
CPCB	Central Pollution Control Board
CRE	Carbapenem Resistant Enterobacteriaceae
CRO	Carbapenem-Resistant Organisms
CSSD	Central Sterile Supply Department
ECDC	European Centre for Disease Prevention and Control
EPA	Environmental Protection Agency
ESBL	Extended-spectrum beta-lactamase
EVD	Ebola Virus Disease

HAI	Healthcare-Associated Infection
HEPA	High-Efficiency Particulate Air
HICC	Hospital Infection Control Committee
HICPAC	Healthcare Infection Control Practices Advisory Committee
ICMR	Indian Council of Medical Research
IDSP	Integrated Disease Surveillance Programme
IPC	Infection Prevention and Control
LRP	Learning Resource Package
MoHFW	Ministry of Health and Family Welfare
MRSA	Methicillin-Resistant Staphylococcus Aureus
NCDC	National Centre for Disease Control
NSI	Needle-Stick Injury
OSHA	Occupational Safety and Health Administration
PCR	Polymerase Chain Reaction
PCRA	Point-of-Care Risk Assessment
PPE	Personal Protective Equipment
PEP	Post Exposure Prophylaxis
QUATs	Quaternary Ammonium Compounds
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SSI	Surgical Site Infection
UTI	Urinary Tract Infection
VAP	Ventilator-Associated Pneumonia
VRE	Vancomycin-Resistant Enterococcus

First Expert Advisory Group Meeting

From Concept to Creation

Introduction

Pandemics have shaped human history, leaving a profound impact on societies and healthcare systems. Throughout the ages, various infectious diseases have swept across continents, causing widespread devastation. Amidst these challenges, healthcare workers have played a pivotal role in combating pandemics. Their expertise, dedication, and resilience have been critical in saving lives and minimizing the impact of these global health crises. To enhance their preparedness for future pandemics, there is a pressing need for a comprehensive learning resource package that equips healthcare workers with the knowledge and skills necessary to tackle emerging infectious diseases effectively.

History of Pandemics

Pandemics have plagued humanity for centuries, altering the course of history. COVID-19 is not the first pandemic to affect humanity. Throughout history, various infectious diseases have caused widespread devastation. From the

Black Death in the 14th century to the Spanish flu in the early 20th century, pandemics have reshaped societies and tested healthcare systems. The COVID-19 pandemic, caused by the novel coronavirus (SARS-CoV-2), has impacted millions of lives worldwide and presented unique challenges in the 21st century. The Black Death (1347 to 1351 AD) caused by the bubonic plague, ravaged Europe and resulted in an estimated 75-200 million deaths. The Spanish Flu (1918-1919 AD) infected over 500 million people worldwide, claiming the lives of 20-50 million individuals. More recent pandemics include the H1N1 influenza pandemic (2009- 2010 AD), which spread to nearly every country.

In each era, healthcare workers have confronted these diseases head-on. From the plague doctors of the medieval period to the modern-day physicians and nurses, their service and expertise have been vital in controlling the spread of diseases, providing care, developing vaccines, and establishing treatments.

Role of Healthcare Workers in Pandemics

During pandemics, healthcare workers are at the forefront, confronting numerous challenges. They work tirelessly to diagnose and treat patients, implement infection control measures, and provide emotional support to the affected individuals and their families. These dedicated professionals are often exposed to high-risk environments, risking their own health and safety for the greater good.

In addition to their direct patient care roles, healthcare workers also contribute to vital research efforts. They collaborate with scientists and public health experts to identify the source of outbreaks, track the spread of diseases, and develop effective strategies for containment and mitigation.

Management of Pandemics

The management of pandemics involves a multi-faceted approach that relies heavily on the expertise and dedication of healthcare workers. These professionals are responsible for surveillance and early detection of emerging infectious diseases, implementing appropriate infection prevention and control measures, and ensuring the availability of medical resources and supplies. Moreover, healthcare workers play a crucial role in public health communication and education. They disseminate accurate information, debunk myths and misconceptions, and infection control preventive measures such as hand hygiene, mask-wearing, and vaccination.

The Need for a Learning Resource Package

To strengthen the response to future pandemics, it is essential to provide healthcare workers with a comprehensive Learning Resource Package (LRP) with up-to-date information on emerging infectious diseases, their epidemiology, and appropriate infection prevention and control strategies.

The LRP would ensure that healthcare workers receive consistent and evidence-based information. It would offer a standardized framework for training, allowing for efficient dissemination of knowledge across diverse healthcare settings.

Furthermore, this package should be regularly updated to reflect the evolving nature of infectious diseases and incorporate lessons learned from previous pandemics. It should also emphasize interdisciplinary collaboration, fostering partnerships between healthcare professionals, public health agencies, researchers, and policymakers.

Methodology

The LRP was developed by the project team by systematically reviewing the existing scientific literature on Infection Prevention and Control, Including Biomedical Waste Management. The technical content was curated from various guidelines which included the Ministry of Health and Family Welfare (MoHFW), Government of India (GoI) resources and guidelines from the World Health Organization (WHO) and the Indian

Council of Medical Research (ICMR) resources. The aim of this exercise was to synthesize and summarize the evidence and convert it into an LRP. LRP will organize the contents into a training package consisting of Systemic Operating Procedures (SOPs), job aids for various cadre of healthcare workers and training workshops.

An Expert Advisory Group on Infection Prevention and Control (IPC) including Biomedical Waste Management consisting of subject experts was constituted for advising on the LRP and vetting the developed resource material. Five sub-groups were formed which deliberated and reviewed upon the LRP under subject heads of Hand Hygiene, PPE,

Group Discussions during Expert Advisory Group Meeting

Disinfection, Biomedical Waste Management, Deadbody Handling, Spill Management, Sharps Safety, Safe Injection Practices and Lesser Explored Variables pertaining to Infection Pandemic Management, Prevention and Control. There were two meetings of the Expert Advisory Group for finalizing the LRP.

To make the training content widely reachable and acceptable, translation of training resources in local languages would also be considered in collaboration with various states.

Reviewing the available guidelines

The process of reviewing the available guidelines for this LRP was both meticulous and comprehensive, in order to provide the most accurate and up-to-date information possible for healthcare workers during a pandemic.

We began with compiling a list of relevant guidelines from various authoritative sources. These included Indian Government guidelines, guidelines provided by the Indian Council of

Expert Advisory Group meeting, New Delhi

Medical Research (ICMR), recommendations from the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), the European Centre for Disease Prevention and Control (ECDC), as well as other national and international authorities on infection control practices.

Each guideline was systematically reviewed by a team of experts with extensive experience in Healthcare and Infection Control Practices. The guidelines were meticulously reviewed to ensure their relevance and applicability in a pandemic scenario.

This helped us to grasp the essence and applicability of each guideline. Then, key points from each guideline were extracted and noted down for further analysis

Next, the team assessed the quality and strength of each guideline based on several factors, such as the credibility of the issuing authority, the level of evidence supporting the guidelines, and the consensus among experts in the field. We also considered factors such as practicality, cost-effectiveness, and cultural appropriateness, particularly for guidelines that would be applicable in diverse settings.

The team compared and contrasted the guidelines, identifying areas of agreement and divergence. This allowed us to get a comprehensive picture of the current understanding and practices in Infection Control. Guidelines were evaluated for coherence and any discrepancies were critically analyzed and resolved with the consultation of experts.

Finally, after considering all these factors, the most pertinent points from the guidelines were integrated into our Learning Resource Package. We made sure that the final resource accurately represents the global consensus on Infection Control practices, while also being adaptable to specific local contexts.

The goal of this process was to create a robust, comprehensive, and easy-to-understand resource for healthcare workers that synthesizes the best advice and practices from around the world.

Systematic Reviews

The systematic review process led to the development of this comprehensive package which was guided by the Preferred Reporting Items for the Systematic Reviews and Meta-Analyses PRISMA guidelines. (PRISMA is an evidence-based minimum set of items designed to help researchers report a wide array of systematic reviews and meta-analyses that assess the benefits and harms of a health care intervention).

A comprehensive literature search was performed across multiple databases. The search strategy was explicitly detailed to ensure transparency and reproducibility. It included a mix of controlled vocabulary and free text terms relevant to Infection, Prevention and Control during Pandemics and Biomedical Waste Management. Covidence software was used for conducting Systematic Reviews.

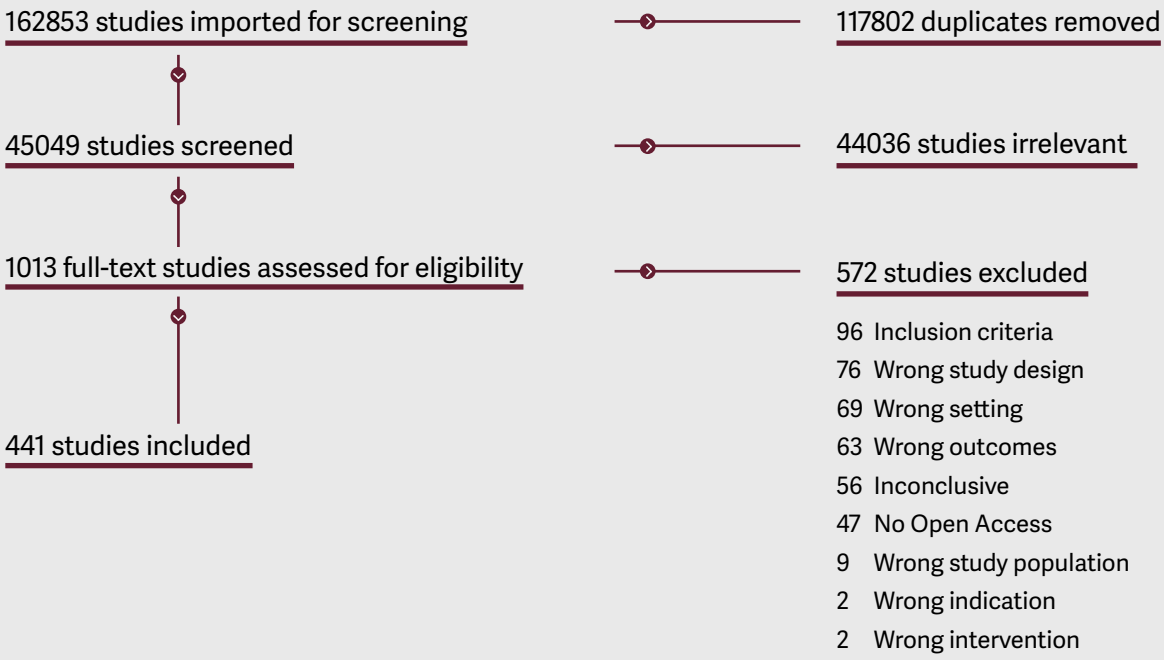
Following the search, all identified records were screened based on their title and abstract. The full texts of potentially relevant studies were then obtained and assessed for eligibility based on predetermined inclusion and exclusion criteria. Studies were excluded if they were not pertinent to the research project.

The data extraction stage involved carefully extracting relevant information from each of the included studies analysing the content narrative and themes of Infection Prevention and Control and Biomedical Waste Management.

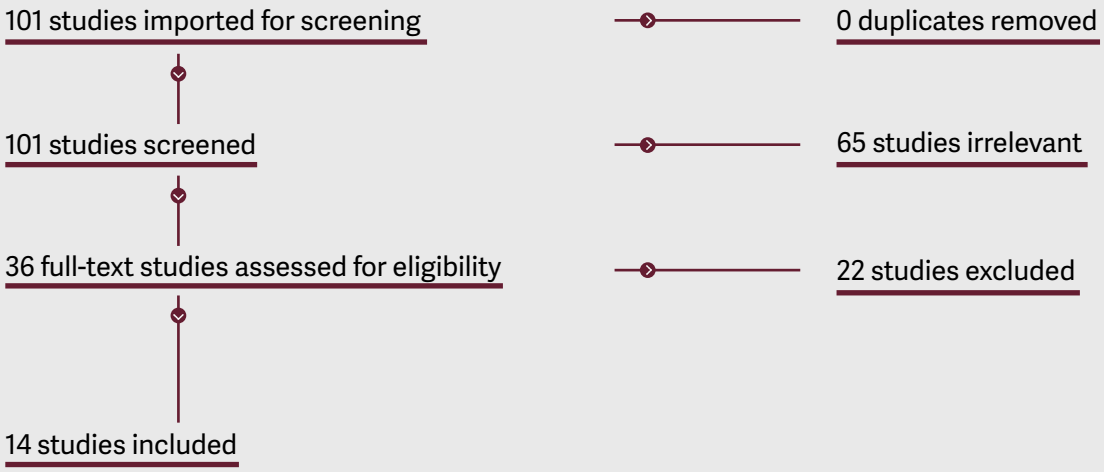
In total, our systematic review process yielded 226 studies relevant to Infection Prevention and Control and 14 studies pertinent to Biomedical Waste Management. The most relevant findings from these studies, in conjunction with the guidelines from various national and international sources, were then synthesized into this comprehensive LRP.

Our goal was to use the rigor of the published evidence based data to ensure that the LRP was of high-quality, reliable evidence, thus providing the healthcare workers with valuable and accurate information for tackling any pandemic.

Systematic Review: COVID-19



Systematic Review: Biomedical Waste Management (BMWM)



Search strategy

1. Review is reported according to Preferred Reporting Items for Systematic Reviews and Meta- Analysis (PRISMA) Guidelines
2. PICOS (Population Intervention Comparison Outcome Study Design) statement.
    a. Population – Hospitals and health care facilities
    b. Intervention- Pandemic preparedness for Infection prevention & control including Biomedical waste management
    c. Comparison- No restriction
    d. Outcome- All measures related to Infection prevention & control including Biomedical waste management.
    e. Study design- No restrictions
3. Search Strategy:
    a. Databases: PubMed, Excerpta Medical Data Base (EMBASE), Cochrane
    b. Manual search of reference list of reviewing studies
    c. Guidelines issued by various scientific, statutory, government and non-governmental agencies
    d. Use of Boolean operators
4. Key words:
    a. Infection prevention & control:
        - Infection control
        - Pandemic preparedness
        - Standard Precautions
        - Transmission based precautions.
    b. Combination of words:
        - (Infection control) AND (Pandemic Preparedness),
        - (Infection control) AND (Standard Precautions),
        - (Infection control) AND (Transmission Based Precautions),
        - (Pandemic Preparedness) AND (Standard Precautions),
        - (Pandemic Preparedness) AND (Transmission Based Precautions),
        - (Standard Precaution) AND (Transmission based precautions),
        - (Infection control) AND (COVID-19)
    c. Biomedical waste management:
        - Biomedical waste management
        - Pandemic
    d. Combination of words:
        - (Biomedical waste management) AND (Pandemic)
5. Inclusion criteria:
    a. Studies published in English language within past 30 years (1992-2022)
    b. Topic of interest for outcome: Infection prevention and control

i. Standard precautions:
    - Hand Hygiene,
    - Wearing Personal Protective Equipment (PPE), glove use, masks use and protective eye wear
    - Respiratory hygiene
    - Sharp injury prevention and management,
    - Safe injection practices,
    - Disinfection and sterilization of Instruments
    - Cleaning and disinfection of environment

ii. Transmission based Precautions.

iii. Spill Management

iv. Dead body management

v. Pandemic preparedness

vi. Any other pertinent domain identified during the systematic review.

vii. Biomedical waste Management:
    - Segregation of Biomedical waste
    - Transport of Biomedical waste
    - Storage of Biomedical waste
    - Disposal of Biomedical waste
    - Biomedical waste in Laboratory and sample collection
    - Pandemic preparedness

vii. Studies involving following groups: Physicians, Hospital Administrators/ Managers, Public health specialists, Nurses, Laboratory specialists, technicians, and Technologists, Hospital Attendants, Sanitary Attendants, Community health care workers etc.

viii. Studies including supply chain of PPE, as during the COVID 19 pandemic rose as one of the major challenges for ensuring optimal infection control practices.

6. Exclusion criteria:
    a. Antibiotic related topics (Ex: Antimicrobial Stewardship Program)
    b. Pre and Post exposure prophylaxis
    c. All other categories of industries
    d. Vaccinations
    e. Sero-epidemiological studies
    f. Medical management strategies
    g. KAP studies

Note on the Formation and Refinement of the LRP

Following the exhaustive process of reviewing selected guidelines and analyzing the articles resulting from the systematic reviews, a preliminary draft of the LRP was composed. This draft was not crafted in isolation but was born out of the collective insights from the first meeting with our panel of experts.

During this initial meeting, experts engaged in thorough discussions, where they shared their interpretations of the guidelines and systematic review findings, proposed the structure and content of the LRP, and laid out the critical elements that needed to be included. Their valuable inputs served as the backbone for creating the draft.

This initial draft was then presented at a second meeting with the experts, where it was meticulously examined, discussed, and critiqued. In this constructive setting, the experts provided their suggestions and changes to enhance the draft's clarity, accuracy, relevance, and applicability. This included recommendations on the order and flow of the chapters, the depth and breadth of the content, and the overall usability of the resource.

Incorporating these insightful suggestions, the draft was then revised to finalize the LRP. It was expanded to include a total of 14 chapters, each focusing on distinct but interconnected areas of pandemic response and biomedical waste management. Each chapter was designed to provide comprehensive knowledge and skills, backed by the best available evidence and expert opinion.

Finally, this refined copy of the LRP with its 14 chapters was sent to all the experts for their final review and endorsement. This iterative and collaborative process ensured that the final version of the LRP is not only based on sound evidence and guidelines but also tailored to the practical needs and realities of healthcare workers on the ground.

First Expert Advisory Group Meeting, New Delhi

List of Guidelines

1. Infection prevention and control guidance to action tools – WHO
2. National Guideline for Infection Prevention and Control in Healthcare Facilities – NCDC, MoHFW India
3. Hospital Infection control guidelines – ICMR
4. Infection management and environmental plan – NHM
5. National Guidelines for IPC in HCF – MOHFW
6. Infection Prevention and Control – Jhpiego
7. Principles for Infection Prevention and control-COVID 19 Patients- NHSRC
8. WHO best practices for injections and related procedures toolkit
9. WHO guidelines on drawing blood: best practices in phlebotomy
10. WHO guideline on the use of safety-engineered syringes for intramuscular, intradermal and subcutaneous injections in health care settings
11. WHO Guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge Clean Care Is Safer Care
12. National Infection Prevention and Control Guidelines (2016) – WHO Africa
13. Strengthening infection prevention and control in primary care - WHO
14. Infection Control Manual - AIIMS, New Delhi
15. CDC Guidelines for standard precautions
16. Infection prevention and control and preparedness for COVID-19 in healthcare settings – ECDC
17. National infection prevention and control manual for England – NHS
18. HICPAC guidelines for isolation precautions
19. ACORN Standards Applied to Practice (ASAP)
20. Australian Guidelines for the Prevention and Control of Infection in Healthcare
21. Practice guidance for infection prevention – APIC
22. Standards and Recommendations for Safe Perioperative Practice - The Association for Perioperative Practice
23. Guidelines on Airborne Infection Control April- TBC INDIA
24. Infection Prevention and Control Practice Standard- New Zealand
25. Transmission based precautions | PHA Infection Control
26. NHS England » Chapter 2: Transmission based precautions (TBPs)
27. Transmission-Based Precautions - www.cec.health.nsw.gov.au
28. Winnipeg Regional Health Authority Acute Care Infection Prevention & Control Manual
29. Canada PHA of. Routine Practices and Additional Precautions for Preventing the Transmission of Infection in Healthcare Settings
30. Contact Precautions - MN Dept. of Health
31. Transmission-Based Precautions | Basics | Infection Control | CDC
32. Guidelines for Management of Healthcare Waste as per Biomedical Waste Management Rules, 2016-CPCB
33. Safe Management of Blood and Body Fluids Community Infection Prevention and Control Policy for Domiciliary Care staff Safe management of blood and body fluids- UK
34. Kayakalp - Swacchta Guidelines for Public Health Facilities
35. Blood spillage - WHO Guidelines on Drawing Blood
36. World Health Organization. Safe management of waste from healthcare activity.
37. Measures to Reform National Infection Prevention and Control System for the Purpose of Immediate Response to Emerging Infectious Diseases- Republic of South Korea

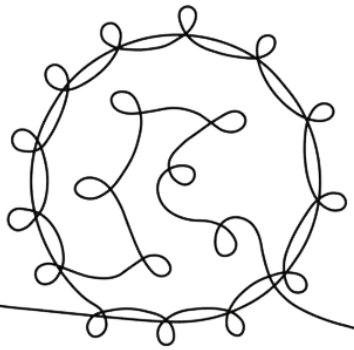
Contents of this Chapter

Chapter 1

Prevention of Healthcare Associated Infections including Standard Precautions

Picture Credit: AIIMS, New Delhi

Prevention of Healthcare associated Infections including Standard Precautions



Infection

Infection is defined as the entry of pathogens into tissues, their growth, and the host tissues' response to the infectious agent and the toxins they generate. Any ailment brought on by a pathogen or its toxic byproduct that spreads from an infected human, animal, or contaminated inanimate object to a host is referred to as an infectious disease. [1-6]

Symptoms and signs might differ according to the type of infection, although fever and exhaustion are common ones. While certain infections might be fatal and require hospitalization, others can be treated at home with rest and supportive care.[7] Certain contagious illnesses, like measles and chickenpox, can be avoided through vaccination. Regular and diligent hand hygiene stands as a crucial measure in preventing infections.[4]

The Epidemiological Triad: (Agent–Host–Environment)[8-11]

The Epidemiological Triad is a conceptual model commonly used in Epidemiology to understand and analyse infectious diseases. It suggests that the occurrence of an infectious disease is the result of the interaction between three components: the host, the agent, and the environment. While the specific details may vary depending on the infection being studied, the general framework remains consistent. Here's an overview of the components of the Epidemiological Triad:

- **Host:** The host refers to the individual or organism that can be infected by the disease. The characteristics of the host, including age, sex, genetic makeup, immunity status, and underlying health conditions play a crucial role in determining susceptibility to the infection. For example, certain age groups or individuals with weakened immune systems may be more vulnerable to specific diseases

Figure 1.1 Major type of Pathogens

Virus | Bacteria | Fungi | Protozoa | Helminths

- **Agent:** The agent represents the biological or physical factor that causes the infection. It can be a microorganism such as a bacterium, virus, fungus, parasite, or a non-living agent like a toxin or a chemical substance. The agent's properties, such as its virulence, mode of transmission, and ability to survive in the environment influence its potential to cause disease
- **Environment:** The environment encompasses the external factors that facilitate or hinder the transmission of the infectious agent. It includes both the physical and social environment. Physical factors may include temperature, humidity, altitude, geographical location, and availability of resources like clean water and sanitation facilities. Social factors involve human behaviour, cultural practices, socioeconomic status, healthcare infrastructure, and access to healthcare services. The environment can affect the agent's survival, the host's vulnerability and the opportunities for transmission

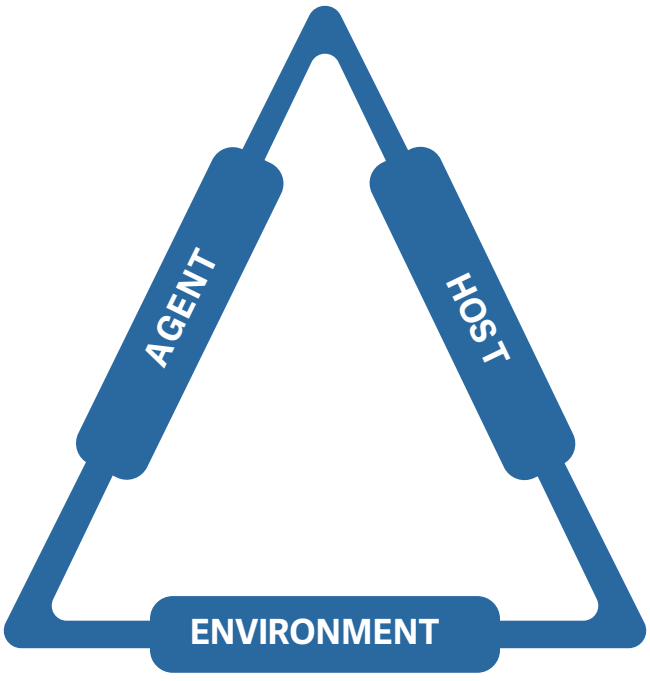
These three things together—host, agent, and environment—determine how diseases happen and spread. If any of these things are out of balance, it can affect how bad the disease becomes. Scientists study these factors to understand diseases better and to figure out how to stop them from spreading.

The Epidemiological Triad for Healthcare-Associated Infections (HAIs) consists of host factors, agent factors, and environmental factors.

- Host factors include susceptibility, immunization status, and the history of invasive procedures
- Agent factors involve the virulence of the infectious agents, drug resistance, and colonization by potential pathogens
- Environmental factors encompass healthcare facility design, infection control practices, and patient population/staffing levels

Understanding and addressing these factors is essential for preventing and controlling HAIs. Measures such as infection control, hand hygiene, and maintaining a clean environment are crucial in mitigating HAI risks.

Figure 1.2 **Epidemiological Triad of Infections**



Chain of Transmission of Infections[9, 12-15]

The Chain of Transmission of Infections refers to the sequence of events that must occur for an infectious disease to spread from one person to another. The Chain of Transmission of Infections consists of six interdependent links in the sequence given below:

Table 1.1: Components of Chain of Transmission[16]

Microorganisms	Disease producing, also called pathogens • Virus, parasite, fungus, bacterium • Risk factors: Virulence, pathogenicity, ability to enter host
Reservoir/Source	Environment/habitat where a pathogen can live and multiply • Environmental surfaces/equipment, body fluids (blood, saliva), urine/fecal material, food/water, soil, skin, respiratory tract
Portal of Exit	How the pathogen exits or leaves reservoir • Skin to skin, skin to surface, blood, mucous membranes, oral cavity, faeces • Other potentially infectious matter (OPIM): Seminal fluid, joint fluid, saliva, urine/faecal matter, any body fluid contaminated with blood
Modes of Transmission	How a pathogen moves from reservoir to susceptible host • Direct Transmission: Airborne, droplet, contact (e.g., skin), bite, needlestick or other sharps injury • Indirect Transmission: Fomites – contaminated equipment or medication (multidose vials, single dose vials), vectors, food, water
Portal of Entry	Opening where the pathogen may enter • Body openings (e.g.: mouth, eyes, urinary tract, respiratory tract), incisions, wounds
Susceptible Host	The person at-risk: Patient or Healthcare Worker • Factors affecting susceptibility (e.g., age, health, co-morbidities, immune system, nutrition, infective dose, medications)

Breaking the chain of infection transmission by interrupting these links can prevent the spread of infectious diseases. E.g.: performing hand hygiene, wearing PPE and practicing good respiratory hygiene. Understanding the Chain of Transmission equips healthcare workers with the knowledge to break the chain and prevent the spread of contagious illnesses. (Ref. Figure 1.3)

Figure 1.3 **Chain of Transmission of Infection**
(Image source: https://hub.geneplanet.com/en/covid-19-how-to-break-the-chain-of-infection/)

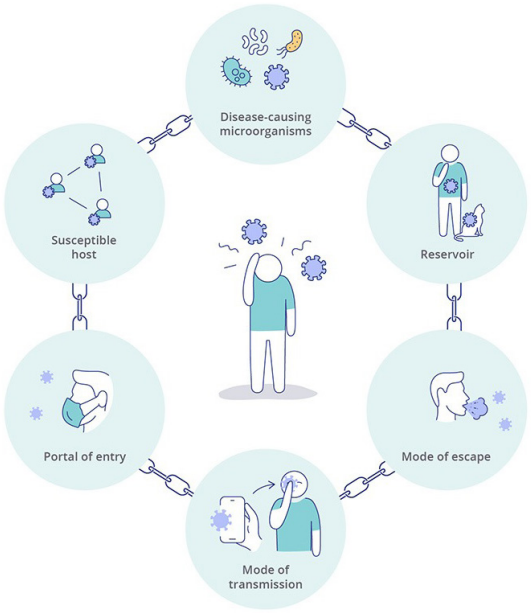


Table 1.5: Links in the chain of infection[17]

Chain of transmission	Breaking the chain
Infectious agent	• Hand hygiene • Cleaning • Disinfection/ Sterilization
Reservoir • People • Animals • Inanimate environment	• Environmental cleaning • Waste management • Disinfection/ Sterilisation of surfaces/ equipment
Portal of exit • Excretions and secretions • Non-intact skin (e.g.: draining nose) • Respiratory tract • Gastrointestinal tract • Mucous membrane	• Hand hygiene • PPE • Environmental cleaning • Containing excretions and secretions
Mode of transmission • Contact • Droplet • Airborne • Contaminated food • Vector • Parenteral	• Hand hygiene • PPE • Environmental cleaning • Respiratory etiquette • Spatial separations • Air flow control
Infectious agent	• Hand hygiene • Cleaning • Disinfection/ Sterilization
Reservoir • People • Animals • Inanimate environment	• Environmental cleaning • Waste management • Disinfection/ Sterilisation of surfaces/ equipment
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Mode of transmission • Contact • Droplet • Airborne • Contaminated food • Vector • Parenteral	• Hand hygiene • PPE • Environmental cleaning • Respiratory etiquette • Spatial separations • Air flow control
Portal of entry • Non-intact skin • Respiratory tract • Gastrointestinal tract • Mucous membrane • Parenteral	• Hand hygiene • PPE • Preventing skin breakdown • Safe use/ handling of sharps • Aseptic technique • Catheter care

Susceptible host

- Elder persons
- Immunocompromised
- Invasive diseases
- Poor nutrition

- Immunization
- Isolation
- Recognition of high risk residents
- Treatment of underlying disease

Breaking the chain of Transmission of Infection

Breaking the chain of transmission of infection is an important concept in public health and involves interrupting the various steps involved in the transmission of infectious diseases. There are six links in the chain of infection and breaking any of these links can prevent the spread of infectious diseases.

Susceptibility of Host [18]

Host susceptibility plays an important role in acquiring HAIs. The following factors impact the susceptibility of a host to an infection:

a. **Immunity:** Individuals with weakened immune systems, including those with HIV/AIDS, autoimmune diseases, or undergoing chemotherapy/radiotherapy, are more at risk of contracting Hospital-Acquired Infections (HAIs).

b. **Age:** Infants, children and elderly individuals have weak immune systems, making them more susceptible to HAIs.

c. **Underlying co-morbidities:** Underlying comorbidities can increase the risk or susceptibility of HAIs in several ways. For e.g., comorbidities that may increase the risk of infections include COPD (Chronic Obstructive Pulmonary Disease), Diabetes, HIV, heart diseases, kidney diseases etc.

d. **Patients undergoing diagnostic or therapeutic interventions:** Patients on devices such as central line or intravenous (IV) or urinary catheters or endotracheal tubes etc., are at increased risk of Hospital Associated Infections (HAI).

e. **Patients receiving blood transfusions:** Patients receiving blood transfusions are at an increased risk of HAIs for several reasons. Blood transfusions can introduce foreign microorganisms into the body, increasing the risk of infection. Additionally, blood transfusions can suppress the immune system, making the recipient more susceptible to infections.

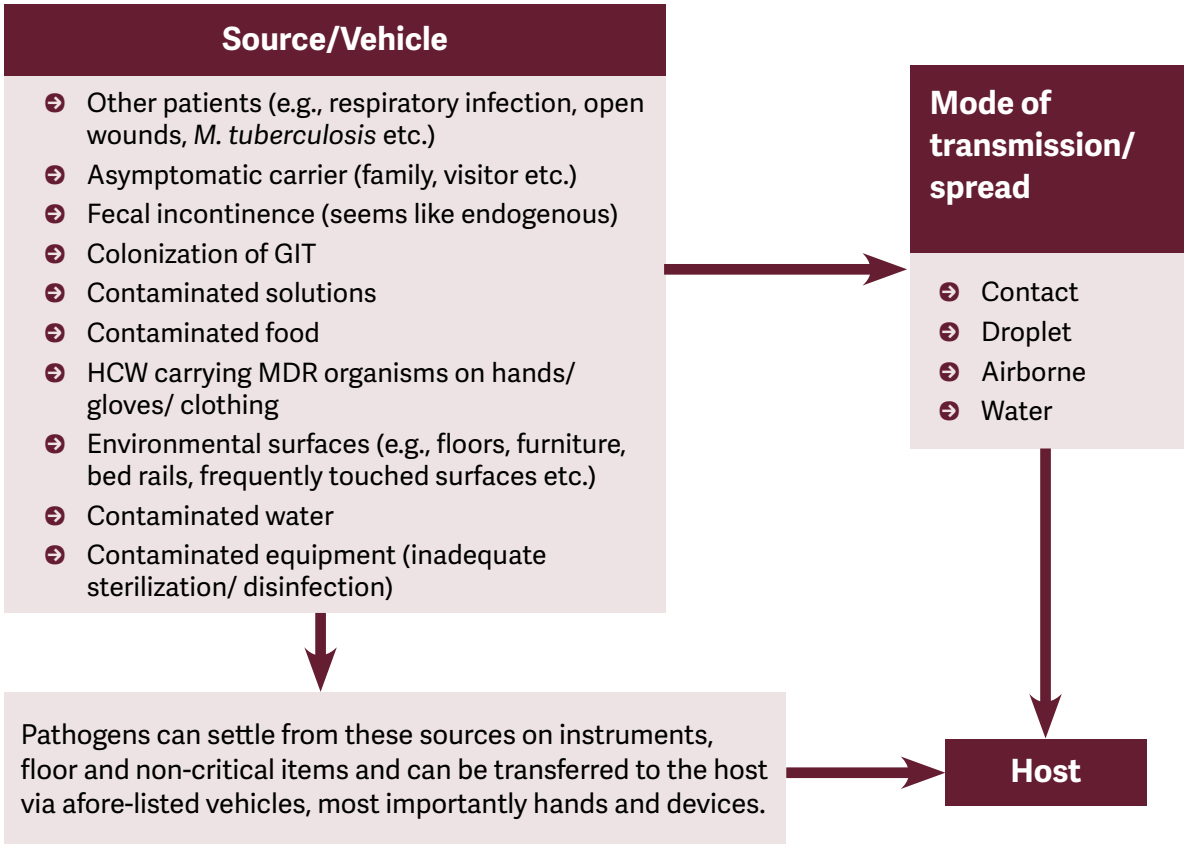
Sources of Infection [12, 19, 20]

Healthcare-Associated Infections (HAIs) can originate from both endogenous and exogenous sources

Endogenous HAIs: Endogenous sources refer to the patient's own microorganisms that become pathogenic or cause infection due to various factors such as compromised immune systems, invasive procedures, or underlying medical conditions. These microorganisms can include bacteria, viruses, fungi, or other pathogens that are normally present in the patient's body without causing harm. However, when the patient's immune system is weakened or disrupted, these microorganisms can multiply and cause infections. Some examples of endogenous HAIs include Surgical Site Infections resulting from bacteria present on the patient's skin or Urinary Tract Infections caused by bacteria already residing in the patient's urinary system.

Exogenous HAIs: Exogenous sources of HAIs are external to the patient and are often introduced from the healthcare environment or other patients. These sources can include various reservoirs of pathogens, including contaminated medical equipment, healthcare worker's hands, surfaces in the healthcare facility, or even other patients. Exogenous HAIs can occur through direct contact, droplet transmission, airborne transmission, or through the ingestion or inhalation of contaminated substances. Examples of exogenous HAIs

Figure 1.4 **Epidemiology of Exogenous HAIs[19]**



include Central Line Associated Bloodstream Infections (CLABSI) caused by contaminated catheters, respiratory infections transmitted through contaminated respiratory equipment, or gastrointestinal infections resulting from exposure to contaminated food or water in the healthcare setting.

Transmission of Infections[9, 14, 21, 22]

The mode of transmission describes how a contagious agent is transferred from an infected individual or reservoir to a vulnerable host. The following are the main modes of transmission:

a. **Contact transmission:** Happens when an infected person's bodily fluids (blood, saliva, mucus, etc.) touch another person's mucous membranes (eyes, nose, mouth).

This can occur through direct contact, like touching, or indirect contact, like touching a contaminated surface and then your face

- **Direct:** Germ transmission can occur through direct touch between an infected person and another person. E.g., skin-to-skin contact, kissing, touching, hand- shaking, hugging, etc.
- **Indirect:** Occurs when an infected person contaminates a surface or object, and then another person touches that surface or object. e.g., touching a contaminated doorknob, telephone, or computer keyboard etc. Hence, the surfaces in healthcare facilities may be classified as high-touch or low-touch to target surfaces with higher chances of getting contaminated

b. **Droplet transmission:** Droplet transmission occurs when an infected individual expels respiratory droplets exceeding five micrometers in diameter during activities such as coughing, sneezing, or talking. These droplets, laden with infectious microorganisms, can directly contact the mucous membranes of the eyes, nose, or mouth of another person within close proximity. Alternatively, indirect transmission can occur when droplets settle on surfaces within the immediate environment, potentially contaminating the hands of a susceptible individual who then inadvertently touches their mucous membranes. Unlike airborne transmission, droplet transmission is limited by the weight of the droplets, which typically travel short distances, generally within one to two meters. The common influenza virus is a well-documented example of a pathogen transmitted via this route

c. **Airborne transmission:** Involves infectious agents suspended in the air, allowing them to be inhaled by individuals further away from the infected person. Unlike droplet transmission, airborne particles are significantly smaller, typically less than 5 micrometers in diameter. These tiny aerosols can linger in the air for extended periods, enabling them to travel greater distances through air currents. Examples of diseases transmitted via this route include tuberculosis, measles, and COVID-19

Healthcare Associated Infections (HAIs)

Infections which arise in hospitals are termed "Healthcare Associated Infections" (HAI). Such infections have also been called "nosocomial infections" and sometimes "Hospital Acquired Infections".[23]

Healthcare Associated Infections are[23, 26]

a. Not typically evident or incubating when a patient is admitted to the hospital

b. Symptoms usually appear at least after 2 days of admission

c. Occur in both adult and paediatric patients

d. HAIs also include infections acquired in hospitals, but symptoms appear sometimes after discharge from hospital

- Occupational infections among staff of healthcare facility. e.g., Needlestick injury

Burden of Healthcare Associated Infections

HAIs have detrimental effects on healthcare systems, patients, and their families. HAIs are associated with increased morbidity and mortality, prolonged hospital stays, and health-care costs.[27, 28] The incidence of Healthcare-Associated Infections (HAIs) exhibits significant variation across countries, with a demonstrably higher risk in Low- and Middle-Income Countries (LMICs). Studies suggest that individuals in LMICs are up to 20 times more likely to acquire a HAI.[28, 29]

According to the World Health Organization (WHO)[29]:

- A troubling disparity exists in healthcare-associated infection (HAI) rates across the globe. In high-income countries, an estimated 7 in every 100 hospital patients

Table 1.2: Classification of HAIs[30]

Device Associated HAIs	Non-device associated HAIs
• Central Line-Associated Bloodstream Infections (CLABSI) • Catheter-Associated Urinary Tract Infection (CAUTI) • Ventilator-Associated Pneumonia (VAP)	• Healthcare associated pneumonia other then VAP. • Surgical Site Infections (SSI) • *C. difficile* infections (CDI) • Methicillin Resistant *Staphylococcus aureus* (MRSA) Infection.

contract an HAI. This number jumps to a staggering 15 per 100 patients in low- and middle-income countries (LMICs)

- Healthcare-Associated Infections can affect up to 30% of intensive care patients, and the risk is much higher in low- and middle-income countries (LMICs), especially among newborns, where it can be 2 to twenty times more common than in high-income countries (HICs)
- About 24% of sepsis cases treated in hospitals are healthcare-associated, and nearly half (49%) of sepsis cases with organ dysfunction treated in adult intensive care units originate in hospitals
- Among patients hospitalized with confirmed COVID-19, as many as 41% contracted the virus in healthcare settings, as reported in various studies. Among healthcare workers, the infection rate ranged from 0.3% to 43.3%

Central Line-Associated Bloodstream Infection (CLABSI): Central Line-Associated Bloodstream Infection (CLABSI) is a nosocomial or Healthcare-Associated Infection characterized by the presence of a laboratory-confirmed bloodstream infection in a patient with a central venous catheter (CVC) in place at the time of, or within 24 hours prior to, the onset of symptoms. The infection is considered primary when the cultured organism is not related to an infection from another site.[31, 32]

Central venous catherizations, such as subclavian, internal jugular, or femoral lines, are the most commonly associated devices with CLABSI.[33] The infection can occur at the entry site of the catheter or along the subcutaneous tract of the catheter, referred to as a tunnel infection.[34]
Approximately 3% of hospitalised patients require central line at some point of time during their hospital stay, out of which 3-8% develop CLABSI.

Catheter-Associated Urinary Tract Infections (CAUTI): These are Urinary Tract Infections occurring in an individual whose urinary bladder is catheterized or has been catheterized within the past 48 hours.[35] It occurs when bacteria or other microorganisms enter the urinary tract through the catheter and causes infection. Common signs and symptoms include urinary frequency, urgency, dysuria, pelvic/lower

Figure 1.5 **Various ways a micro organism may enter the indwelling catheter[37]**

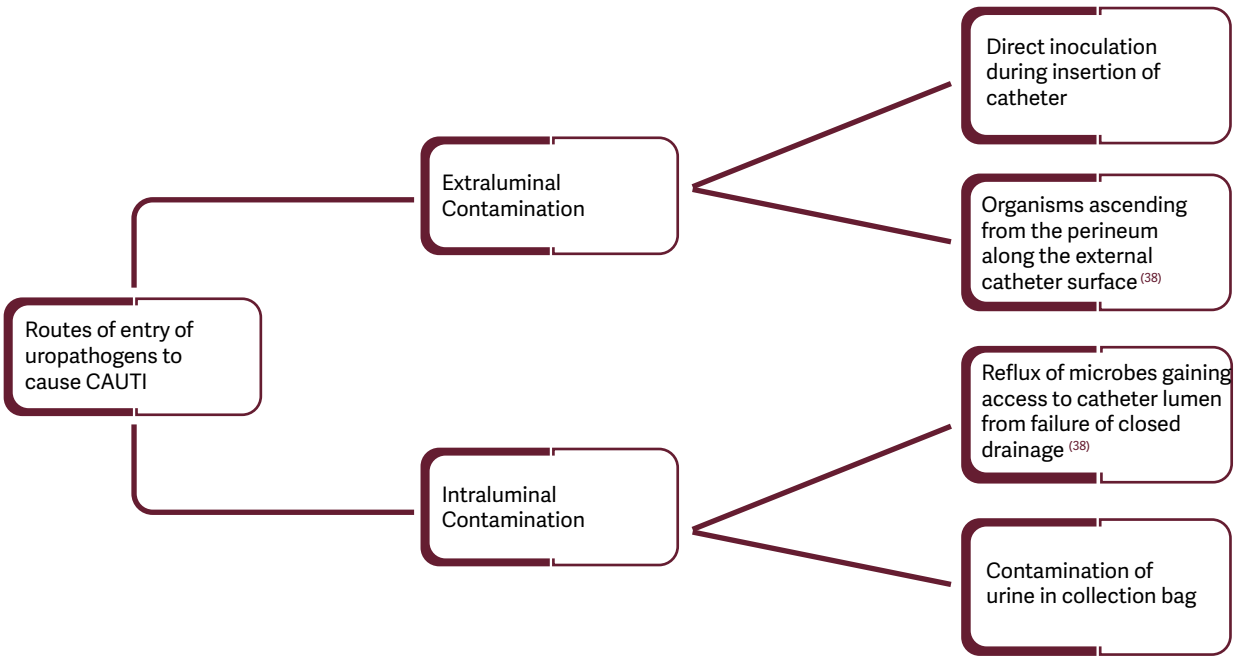
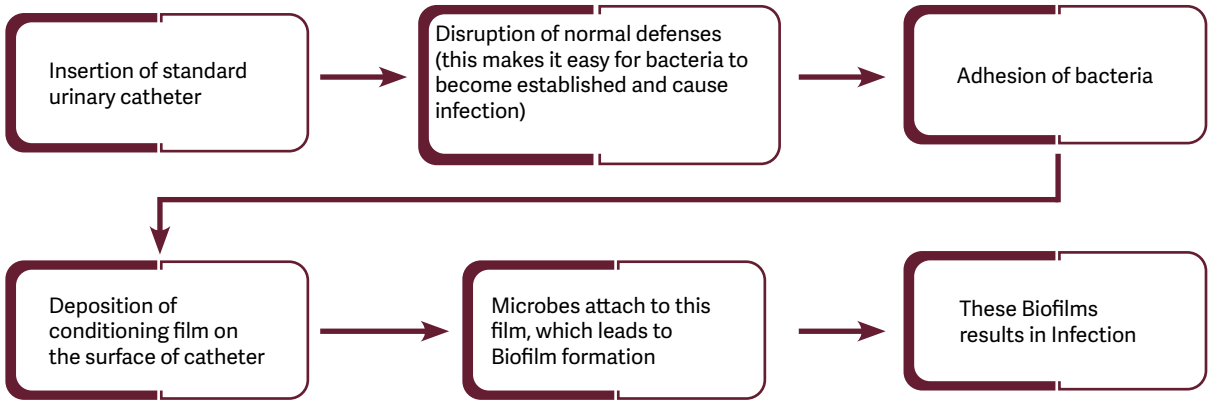


Figure 1.6 **Sequence of events in CAUTI** [37]



abdominal pain, pyrexia and tachycardia. The daily risk of developing CAUTI is 3-7% in acute care setting and is the most common HAI, which comprises 40% of all Hospital Acquired Infections in one year.[36, 37] It differs from uncomplicated (community acquired) UTI in various ways.

Ventilator Associated Pneumonia (VAP): [38] Pneumonia that develops in a patient on mechanical ventilation more than 48 hours after tracheostomy or intubation is known as ventilator associated pneumonia, or VAP. It appears to be an independent predictor of death in critically ill patients and, like other HAIs, lengthens stay in the intensive care unit (ICU).[39] The diagnosis of ventilator-associated

Figure 1.7 **Endogenous and exogenous sources of microorganisms causing Hospital-Acquired Pneumonia (HAP) and Ventilator-Associated Pneumonia (VAP)**[41, 42]

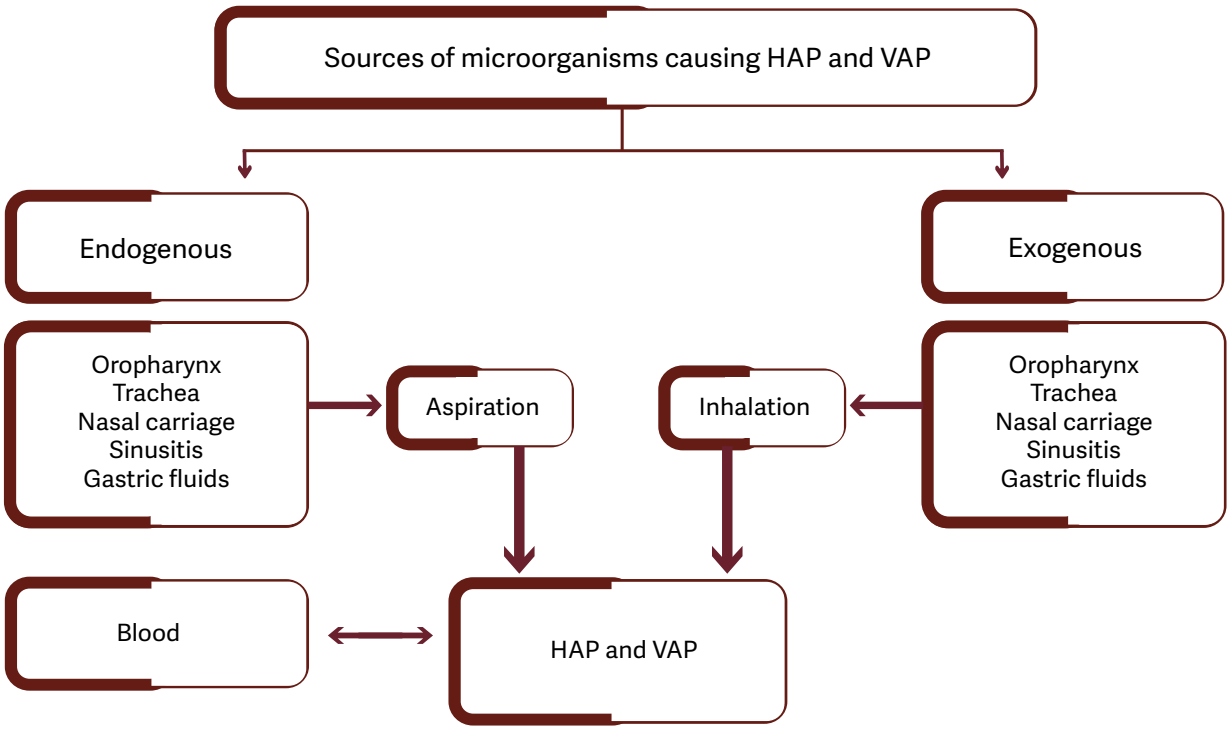
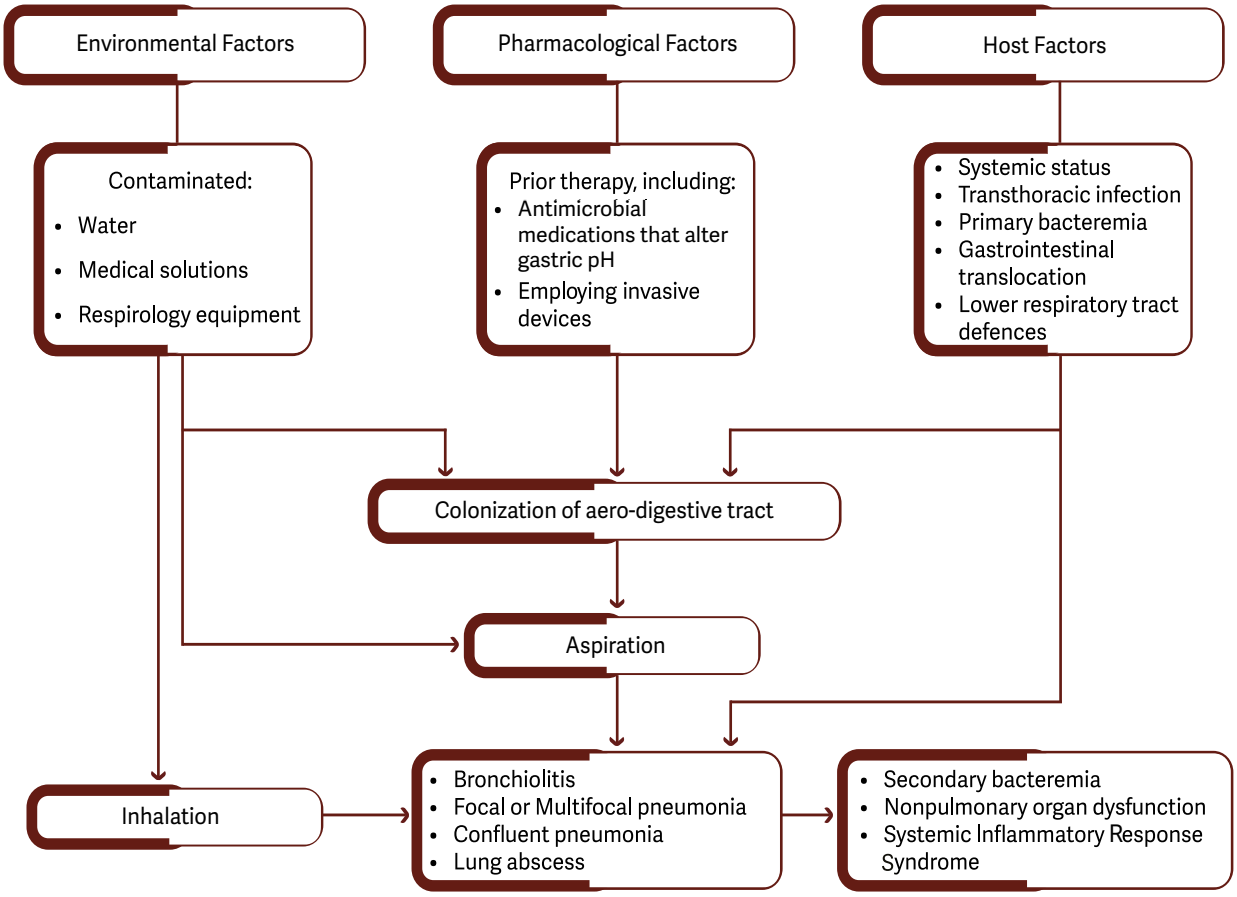


Figure 1.8 **The Pathogenesis of Hospital-Acquired Pneumonia and Ventilator-Associated Pneumonia**



pneumonia (VAP) can be difficult because patients who need mechanical ventilation often have coexisting, complex diseases with identical or confusing signs and symptoms.[40] The following symptoms are required for diagnosis: fever, purulent sputum in the cough, new infiltrate on radiography, and gram-staining of the sputum or ET aspirate.

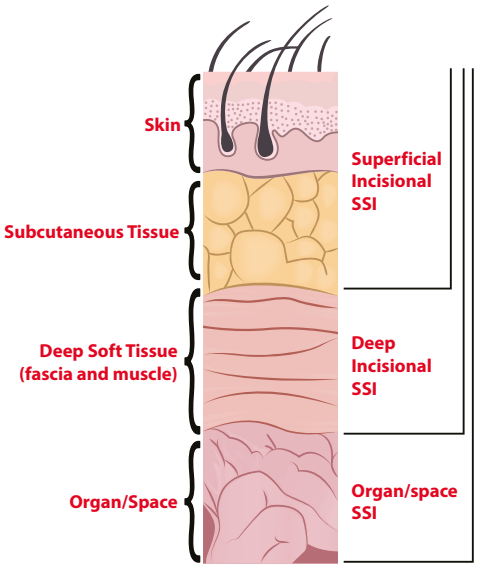
Hospital Associated Pneumonia (HAP). It is one of the most prevalent hospital-acquired infections (HAIs) and frequently goes unreported.[43] Due to the subjectivity and complexity of NV-HAP surveillance, many hospitals just track VAP. Research has indicated that those with weakened immune systems, chronic lung or cardiovascular conditions, as well as the extremely young and old, are susceptible to acquiring NV-HAP.[44] Patients at long-term care institutions have a higher risk of developing NV-HAP, and up to 18% of all pneumonia admissions to acute care hospitals occur with this diagnosis.[45, 46] According to studies, NV-HAP mortality may vary from 15% to 31%.[43, 45, 47, 48, 49]

Surgical Site Infection (SSI): It is defined as an infection that affects the skin and subcutaneous tissue of the incision (superficial incisional), the deep soft tissue (such as fascia, muscle) of the incision, and/or any portion of the anatomy (such as organs and spaces) other than the incision that was opened or manipulated during an operation (organ/space). The infection must occur within 30 days (Table 1.3) following the surgical procedure.[50, 51] A surgical wound's risk of microbial contamination can also be used to categorized as clean, clean-contaminated, contaminated, or dirty infected. In low- and middle-income countries (LMICs), surgical site infections (SSIs) can occur in 8–30% of surgeries.[52]

Table 1.3: Classification of Surgical Site Infections (SSIs) [53, 54]

SSIs	Involving	Associated with at least one of the following
Superficial SSI	Only the skin and subcutaneous tissue of the incision	• Purulent discharge from the superficial incision • Organism identified (by culture/ nonculture method) from a specimen obtained under sterile conditions from a shallow incision or subcutaneous tissue • At least one of the indicators or symptoms: Pain or sensitivity, swelling in a specific area, redness, or increased warmth
Deep incisional SSI	The deep soft tissues affected by the infection, such as the fascial and muscular layers.	• Purulent discharge from the deep incision • Spontaneous separation or intentionally opened or aspirated by a surgeon when the patient exhibits one of the following symptoms: fever exceeding 100.4°F, localized pain, or swelling, unless the culture shows negative results • Infection/ abscess involving the deep incision detected on gross or histopathological or radiological examination
Organ space SSI	Any area of the body beyond the fascial/muscle layers that is accessed or manipulated during the surgical procedure.	• Presence of pus drainage from a drain positioned within the organ/space • Identification of microorganisms (through culture or non-culture methods) from fluid or tissue within the organ/space • Detection of an abscess or other signs of infection affecting the organ/ space observed during gross examination, histopathological analysis, or radiological imaging

Figure 1.9 **Classification of Surgical Site Infections**
(Image source: Scottish Surveillance of Healthcare Associated Infection Programme- Health Protection Scotland 2019)



Clostridium difficile Infections (CDI)

Gram-positive spore-forming anaerobe Clostridium difficile is linked to infections ranging from mild-to-moderate diarrhea to serious illness with deadly consequences such toxic megacolon, pseudomembranous colitis, and other problems. It is acknowledged as the primary factor contributing to deaths related to gastroenteritis. Hospital acquired CDI is linked to longer hospital stays, 40% greater costs per diagnosed case, a higher readmission rate, and a higher death rate.[55] Age, exposure to medicines, contacts with the healthcare system, immunosuppression, and certain medications are risk factors for Clostridium difficile infection (CDI). HIV and tuberculosis could be additional risk factors; these are especially important for low- and middle-income countries.[56]

Methicillin Resistant *Staphylococcus* (MRSA) Infection: This is a Staphylococcus aureus infection that is associated with considerable morbidity, mortality, length of stay, and financial burden. It is also difficult to treat due to antibiotic resistance. Hospital-Associated (HAMRSA) and Community-Associated (CA-MRSA) infections are two further classifications for MRSA infections.[57, 58] Their differences include differences in therapy and antibiotic susceptibility in addition to differences in clinical characteristics and molecular biology.[58, 59] MRSA can lead to serious issues in healthcare settings like hospitals and nursing homes, such as bloodstream infections, pneumonia, surgical site infections, sepsis, and even death.[57]

Direct contact with an infected wound or contaminated hands—typically those of healthcare providers—are the common ways that MRSA is transmitted. Moreover, MRSA carriers who do not exhibit symptoms of illness can transfer the bacterium to other individuals (i.e., colonized people).[57, 60]

Infection, Prevention & Control (IPC)

The nature of the healthcare setting makes all patients and workers vulnerable to infection. Infection Prevention and Control (IPC) is a set of measures taken to prevent the transmission of infectious agents from one person to another. The scientific and practical solutions of IPC aim to decrease vulnerability of the patients and protect our communities. They are based on knowledge of infectious disease, epidemiology, and social science.[61, 62] Infection Prevention and Control (IPC) employs a risk management strategy to reduce or prevent the spread of infection.

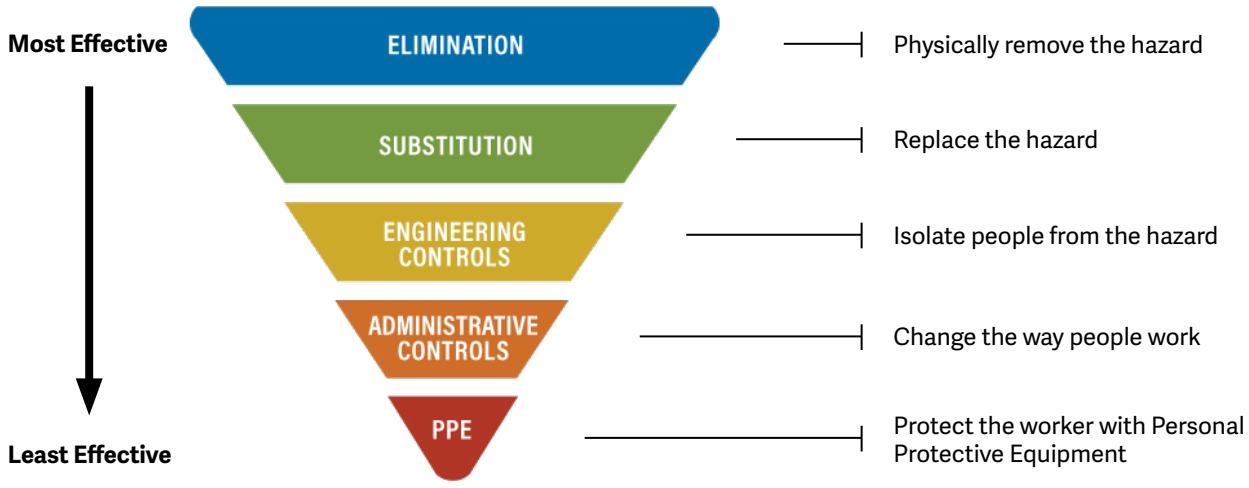
Hierarchy of Controls Approach for IPC[63, 64, 65]

The Hierarchy of Control model is a preventive strategy implemented through design, aiming to address various levels systematically to prevent or minimize occupational injuries, illnesses, and fatalities among healthcare workers. It incorporates prevention considerations into all designs affecting healthcare workers. The model consists of five levels:

- Elimination
- Substitution
- Engineering controls
- Administrative controls
- Personal Protective Equipment (PPE)

The hierarchy's premise is that the protective and/or more effective management techniques may be found at the top of the graphic than at the bottom. By adhering to this hierarchy, healthcare delivery systems are typically implemented with a much lower risk of illness or harm. [64]

Figure 1.10 **Hierarchy of controls approach[66]** (Source: Canadian Centre for Occupational Health and Safety)



- **Elimination (physically removing the hazard):** The controls that eliminate the risk are the most effective ones in the hierarchy of controls. Employers and organizations must rethink the activity in order to completely eliminate the danger. Important mitigating measures could be triaging, screening, and/or testing for infectious diseases specific to the healthcare environment, like RSV, influenza, and SARS-CoV2 [67]
- **Substitution (replace the hazard)**: To lower or control the risk, substitutions should be used when an infectious source cannot be completely eradicated. Sometimes a healthcare facility cannot accomplish this. Nonetheless, certain services could be possible to take into account using virtual consultations (video or phone calls) [67]
- **Engineering controls (control, mitigate or isolate people from the hazard):** Engineering controls are used to minimize the danger of exposure at the source. They can also be used to isolate individuals from the hazard or control it. These include incorporating architectural elements into the building to eliminate hazards at their origin or to enhance adherence to infection control protocols, like installing physical barriers, screens, or bars [67]
- **Administrative controls (change the way people work)**: Administrative controls: It involves modifying work practices, policies, or procedures to keep patients or staff separated from a known hazard. This may include implementing protocols to minimize exposure, providing information and training to staff, and supervising adherence to these measures. Administrative controls also address patient movement within the hospital, ensuring safe traffic flow when infectious diseases are present or suspected [68]
- **Personal Protective Equipment (PPE):** It encompasses specialized clothing and protective gear worn by staff and patients who may encounter known or suspected pathogens. PPE acts as a barrier between staff and potential exposure risks, such as infected patients or diagnostic specimens. Proper use of PPE helps prevent the transmission of pathogens between patients and within the healthcare facility. Personal Protective Equipment (PPE) is regarded as the least efficient measure within the hierarchy of controls because it depends on human elements such as staff adherence, suitable training, and education. Despite their lower effectiveness, lower tiers of PPE still play a crucial role in ensuring effective infection control and should be utilized as necessary [68]

In healthcare settings, there are two tiers of recommended precautions aimed at preventing the spread of infections:

- Standard Precautions
- Transmission-Based Precautions

The two-tiered approach of standard and transmission-based precautions offers a high degree of protection to patients, healthcare workers, and other individuals within healthcare settings.

Standard Precautions

The CDC Guidelines for Isolation Precautions in Hospitals were created in 1996 by HICPAC. It incorporates the main elements of bodily substance isolation and universal precautions, which are currently included in what are known as standard precautions.[69] These are the fundamental measures for infection control that should be applied, at the very least, to every patient's treatment.[70- 73] irrespective of their potential to transmit infection. Table 1.4 illustrates the key elements of the Standard Precautions.

Transmission Based Precautions

These are used in addition to Standard Precautions for patients with known or suspected infection with transmissible and/or epidemiologically significant pathogens.[74, 75] **Three categories of Transmission-Based Precautions have been established based on the modes of transmission. These include Contact Precautions, Droplet Precautions, and Airborne Precautions**. Certain diseases can be transmitted through multiple routes, necessitating the use of more than one category of transmission-based precautions. Whenever

Table 1.4: Key elements of Standard Precautions

	Hand Hygiene
	Personal Protective Equipment
	Respiratory Hygiene / Cough Etiquette Principles
	Needle and sharps injury prevention
	Safe Injection Practices
	Cleaning, Disinfection and Sterilization
	Sterilization Practices

implemented, they are always used in addition to Standard Precautions.

Care bundles

A care bundle is a collection of essential interventions chosen from evidence-based guidelines that are anticipated to improve patients' health outcomes, when put into practice. Care bundles' main objective is to increase patient well-being by streamlining and facilitating adjustments to patient care while encouraging adherence to set protocols.[76] There are several distinct bundles that can be used in healthcare institutions using limited resources. These care bundles aid in the prevention of HAIs, decrease the overuse of antibiotics, and may avoid the emergence of antibiotic resistance in healthcare institutions.

Major HAI care bundles are

- Ventilator-Associated Pneumonia (VAP) Bundle
- Central Line-Associated Bloodstream Infection Bundle
- Catheter-Associated Urinary Tract Infection Bundle

In order to avoid VAP [50, 77]

- Raising the head of the bed (HOB) to a height of thirty to forty five degrees
- Daily assessment of preparedness for extubation and sedative interruption
- Prevention of Peptic Ulcer Disease (PUD)
- Prophylactic treatment for deep vein thrombosis (DVT) (unless contraindicated)
- Using chlorhexidine for daily dental treatment

For prevention of CLABSI[50]

Insertion bundle

- Sterile gloves, a cap, a surgical mask, a sterile gown, and a broad sterile drape are the maximum sterile barrier precautions
- Using alcohol-based chlorhexidine (instead of iodine) to clean the skin
- Using subclavian veins rather than jugular veins for central venous access in adult patients and avoiding the femoral vein
- Committed personnel for competency evaluation and training and central line insertion
- Insertion packs that are standardized
- The use of checklists with experienced observers and the availability of insertion guidelines, including instructions for the use of central lines
- Internal jugular line insertion using ultrasound guidance

Maintenance bundle

- Daily evaluation of the need for central lines
- Efficient elimination of superfluous lines prior to line modification
- Chlorhexidine baths every day (for ICU patients older than two months)
- Before utilizing the catheter, clean its hubs, ports, connectors, etc.
- Every 5-7 days, replace the dressings and clean the area with an alcohol-based chlorhexidine solution (change sooner if filthy)

- Change out the administration sets every 96 hours (or right away if you're using blood products or lipids)
- Make sure the ICU nurse-to-patient ratio is acceptable (1:2 or 1:1)

For prevention of CAUTI[50]

CAUTI insertion bundle

Verify the need prior to insertion. The following are some of the common indications

- Urinary retention/obstruction
- Severely ill/ immobility
- Lack of bladder control
- Patient request/ end of life
- Perioperative – selected surgical procedure
- Assisting with pressure ulcer healing for incontinent patients

Insert urinary catheter using aseptic technique by using

- Hand hygiene
- Catheter insertion kit with sterile gloves, drape, cleaning supplies.
- Sterile lubricant
- Sterile urinary catheter attached to a drainage bag

Maintain urinary catheter based on recommended guidelines

- Secure the catheter to avoid urethral discomfort
- Continue the unhindered flow
- Keep the drainage bag above the ground and below the bladder's level

Perform hand hygiene before and after each patient contact

- Place a bedside collection container with labels for each individual patient
- Determine if a urinary catheter is necessary every day, and remove it as soon as it's not needed

CAUTI maintenance bundle

- Daily documented assessment of need
- Device to secure catheter in place
- Daily meatal hygiene with soap and water
- Hand hygiene before and after patient contact
- Using a fresh container, empty the drainage bag
- Clear passage must be guaranteed

Evidence from Systematic review: Standard precautions[78-80]

The systematic review of multiple studies on standard precautions in Infection Prevention and Control yielded significant findings:

- Integration of Horizontal Interventions: The studies emphasized the importance of horizontal interventions as minimum standards in Infection Prevention, advocating for comprehensive and integrated approaches. Implementing multimodal strategies and stepwise measures is critical, particularly in low-resource settings, to prioritize patient safety over a hospital-centered approach
- Adherence to Standard Precautions: To minimize infection transmission, adherence to Standard precautions is essential, irrespective of a patient's infection status. The primary goal of Infection Control Policies should be to simplify and facilitate compliance among healthcare staff, ensuring that the right actions are taken at the right time across all care settings
- PPE Compliance: While approximately half of the studies reported consistent PPE use based on the patient's condition, overall compliance scores were low, indicating the need for improved adherence
- Effectiveness and Awareness: Standard precautions, replacing universal precautions, are vital for patients and healthcare workers alike. They significantly reduce Healthcare-Associated Infections when followed appropriately. Ensuring awareness and compliance among healthcare workers further enhances Infection Control measures

In conclusion, these studies highlight the critical role of standard precautions and horizontal interventions in Infection Prevention. Consistent adherence to protocols, including proper PPE usage, is crucial in minimizing infection transmission and promoting patient and healthcare worker safety. By implementing integrated approaches and fostering awareness, healthcare settings can effectively prioritize Infection Control and reduce the risk of Healthcare-Associated Infections.

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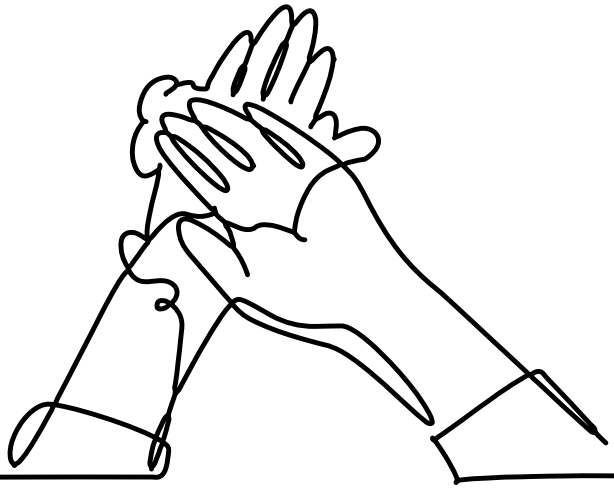
Contents of this Chapter

Chapter 2

Hand Hygiene

Picture Credit: AIIMS, New Delhi

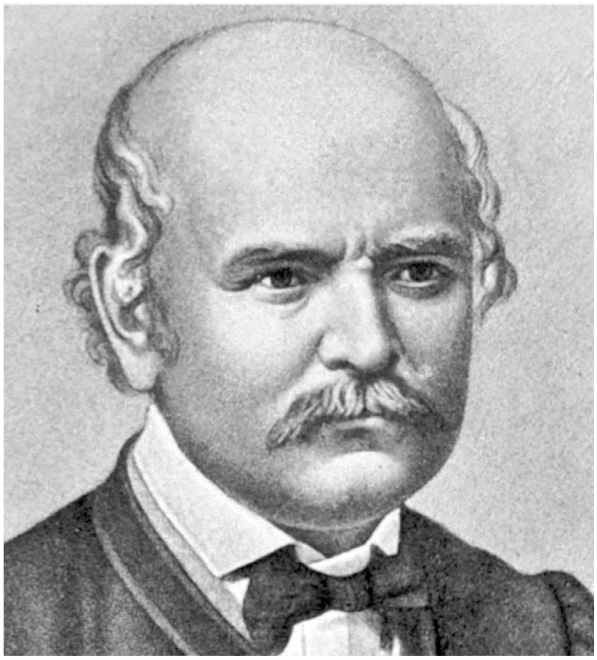
Hand Hygiene



Historical evolution of Hand Hygiene[1-2]

In 19th century, Ignaz Semmelweis, a physician stationed at the obstetrics department of Vienna General Hospital (Allgemeines Krankenhaus) in Austria, documented a statistically significant disparity in mortality rates between childbirth deliveries managed by midwives and those overseen by doctors. It was observed that Physicians and medical students in clinic-1 commenced their daily routine by conducting autopsies on deceased females from the prior evening. These individuals then proceeded to deliver infants throughout the remaining day without intervening hand hygiene practices following the autopsy procedures. It is important to note that all clinical operations at that time were performed barehanded due to the absence of surgical gloves. Notably, midwives in the other Clinic -2 were not involved in autopsy procedures. To address this potential transmission route, Semmelweis implemented a mandatory protocol for students, requiring handwashing with a chlorinated lime solution before every patient examination.[3]

Following 13 years of investigation, Ignaz Semmelweis (1818-1865) published his book, "Etiology, the Concept, and Prevention of Puerperal Fever" (1860). However, the medical community met his work with resistance as it challenged prevailing medical dogma. The germ theory, later substantiated by Louis Pasteur's research (post-Semmelweis' death), provided a scientific framework for Semmelweis' observations. Furthermore, Joseph Lister's successful implementation of hygienic practices



Ignaz P. Semmelweis (1818– 1865)

based on Pasteur's work ultimately led to the wider acceptance of Semmelweis' findings. Ignaz Semmelweis is posthumously recognized as the "Savior of Mothers", the "Father of Infection Control" and also the "Father of Hand Hygiene" for his groundbreaking contributions to the field of modern science.[4]

Compelling scientific evidence highlights hand hygiene as the single most effective strategy to prevent infections, especially when combined with other essential precautions. Studies demonstrate that proper handwashing can significantly reduce preventable diseases by up to 50%, protecting both healthcare

workers and the general public. Beyond COVID-19 vaccination and SARS-CoV-2 containment, good hand hygiene practices are fundamental for minimizing healthcare-associated infections and curbing the development of antibiotic resistance. Furthermore, hand hygiene compliance serves as a critical performance indicator for infection prevention and control programs, ensuring patient safety and upholding the global standards of healthcare delivery.[5, 6]

Table 2.1: Definition of terms related to hand hygiene[2-5]

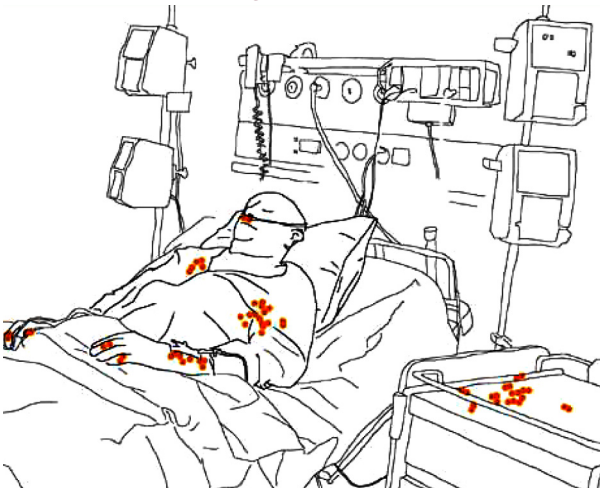
Term	Definition
Hand hygiene	A general term referring to any action of hand cleansing
Antiseptic handwashing	Washing hands with soap and water or with other detergents containing an antiseptic agent
Antiseptic hand-rubbing (or hand-rubbing)	Antiseptic handrubs are topical formulations containing alcohol or other antimicrobials. They reduce or inhibit the growth of microorganisms without requiring an external water source. This eliminates the need for rinsing hands with water and drying with towels
Hand-antisepsis / decontamination / degerming	Hand hygiene can be achieved through two methods: using an antiseptic handrub or performing an antiseptic handwash. Both methods aim to reduce or inhibit the growth of microorganisms on hands.
Alcohol-based (hand) rub	It is a topical formulation available in liquid, gel, or foam form, applied to the hands to inactivate or temporarily suppress the growth of microorganisms.
Non-alcohol-based (hand) rub	The antimicrobial agents used in these products include triclosan, chlorhexidine, iodophors, and quaternary ammonium compounds, as well as their mixtures. e.g., water-based, foams, gels, nano capsules
Antimicrobial (medicated) soap	A concentration of antiseptic ingredient in soap that is enough to render microorganisms inactive and/or momentarily inhibit their growth
Detergent (surfactant)	These are a class of compounds that exhibit cleaning properties and have a unique structure consisting of a hydrophilic head group (attracted to water) and a lipophilic tail group (attracted to oils and fats). This allows them to interact with both water and dirt, facilitating the removal of impurities from surfaces; and are further classified into four main groups based on the charge of their head group: anionic, cationic, amphoteric, and non-ionic.
Plain soap	Antimicrobial compounds are either absent from detergents or present only as preservatives.

Transmission of pathogens by hands[2]

The transmission of pathogens by hands involves a series of steps, as outlined in the provided text. Here is a summary of these steps:

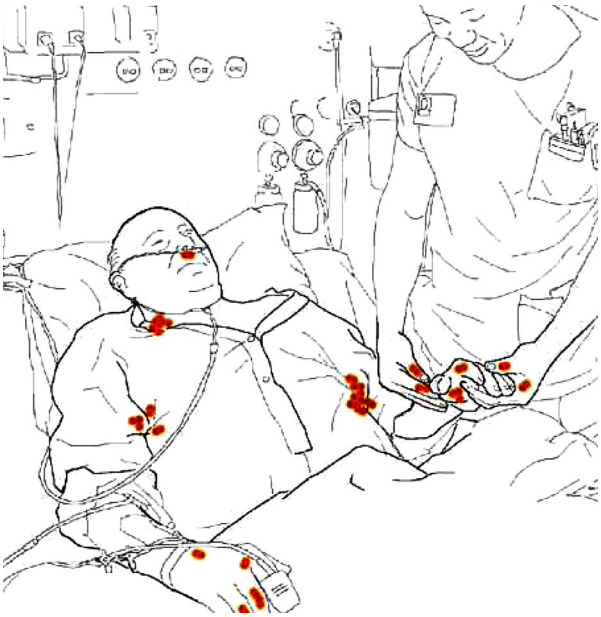
- **Presence of Organisms on Patient Skin or Environment**: Health Care-Associated pathogens can be found not only on infected or wounded skin but also on normal, intact patient skin and the immediate environment. Certain areas of the patient's body, like the perineal and inguinal regions, tend to be heavily colonized, but other areas, including the hands, can also have significant colonization. Contamination of objects in the patient's vicinity is common due to contact with the patient's flora microorganisms

Figure 2.1 Organisms present on patient skin or the immediate environment [2]
(Image source: WHO)



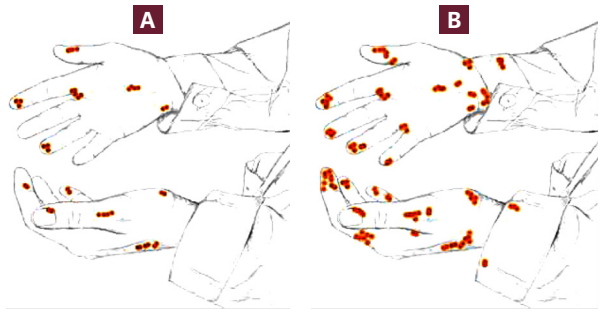
- **Transfer to Health Care Worker's (HCWs) Hands**: Pathogens must be transferred from the patient's skin or environment to the hands of health care workers. This transfer can occur during various patient-care activities, such as lifting patients, taking vital signs, or touching the patient's body. The type and duration of patient care activities affect the degree of hand contamination

Figure 2.2 Transfer of organism from the patient to HCWs' hands[2]



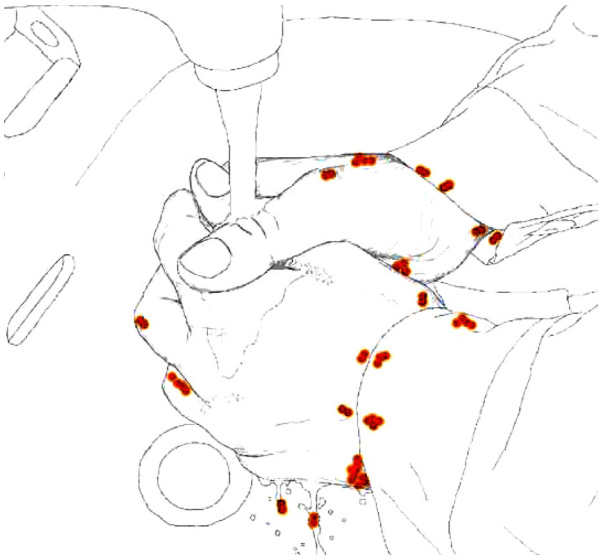
- **Survival on Hands**: Microorganisms can survive on HCW's hands for varying durations. Factors like the type of microorganism and moisture levels can influence their survival. Some studies have shown that bacteria and viruses can persist on hands for extended periods

Figure 2.3 Organism on HCWs' hands (The figure intentionally shows that long-sleeved white coats may become contaminated by microorganisms during patient care.) [2]
(Image Source: WHO)



- **Defective Hand Cleansing**: If hand hygiene practices are inadequate or insufficient, hands may remain contaminated. Factors such as the type of hand hygiene product used, the quantity applied, and the technique used for hand cleansing can impact the effectiveness of hand hygiene

Figure 2.4 **Incorrect Hand washing/ cleansing** [2] (Image Source: WHO)



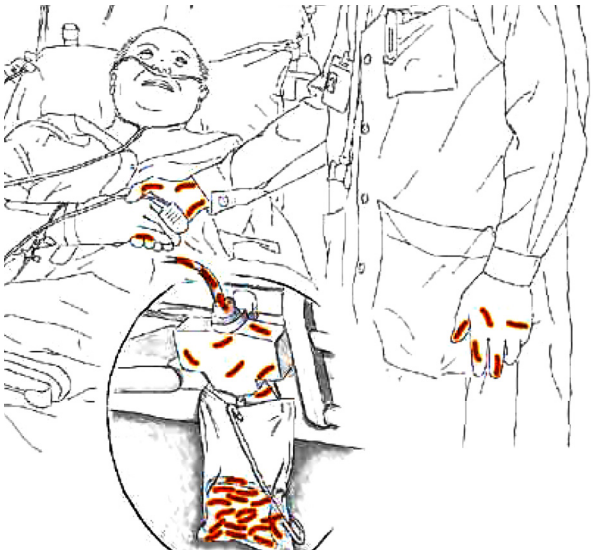
- **Cross-Transmission**: Contaminated hands can lead to the cross-transmission due to pathogens. This occurs when microorganisms are transferred from one surface or individual to another via the hands of Health Care Workers. Pathogens can be transmitted to various surfaces, equipment, or other patients, leading to the potential spread of infections

  (A) The physician's hands were infected after having extended contact with patient A, who had Gram-positive cocci colonization[7]

  (B) Without washing his hands in between, the doctor will now interact directly with patient B. It is possible that an infection will spread from patient A to patient B via the hands of the healthcare worker [7]

Figure 2.5 **Transfer of organism from patient to HCWs' hands** [2] (Image Source: WHO)

Figure 2.6 **Failure to cleanse hands during patient care results in cross-transmission between patients** [2] (Image Source: WHO)



Indications for hand hygiene [8, 9]

01

Wash hands with soap and water when:

- Clearly filthy or clearly soiled with blood or other infectious material (BOIM)
- If exposure to probable spore-forming pathogens—such as Bacillus anthracis or Clostridium difficile—is highly suspected or confirmed
- Before handling medication
- Preparing food

02

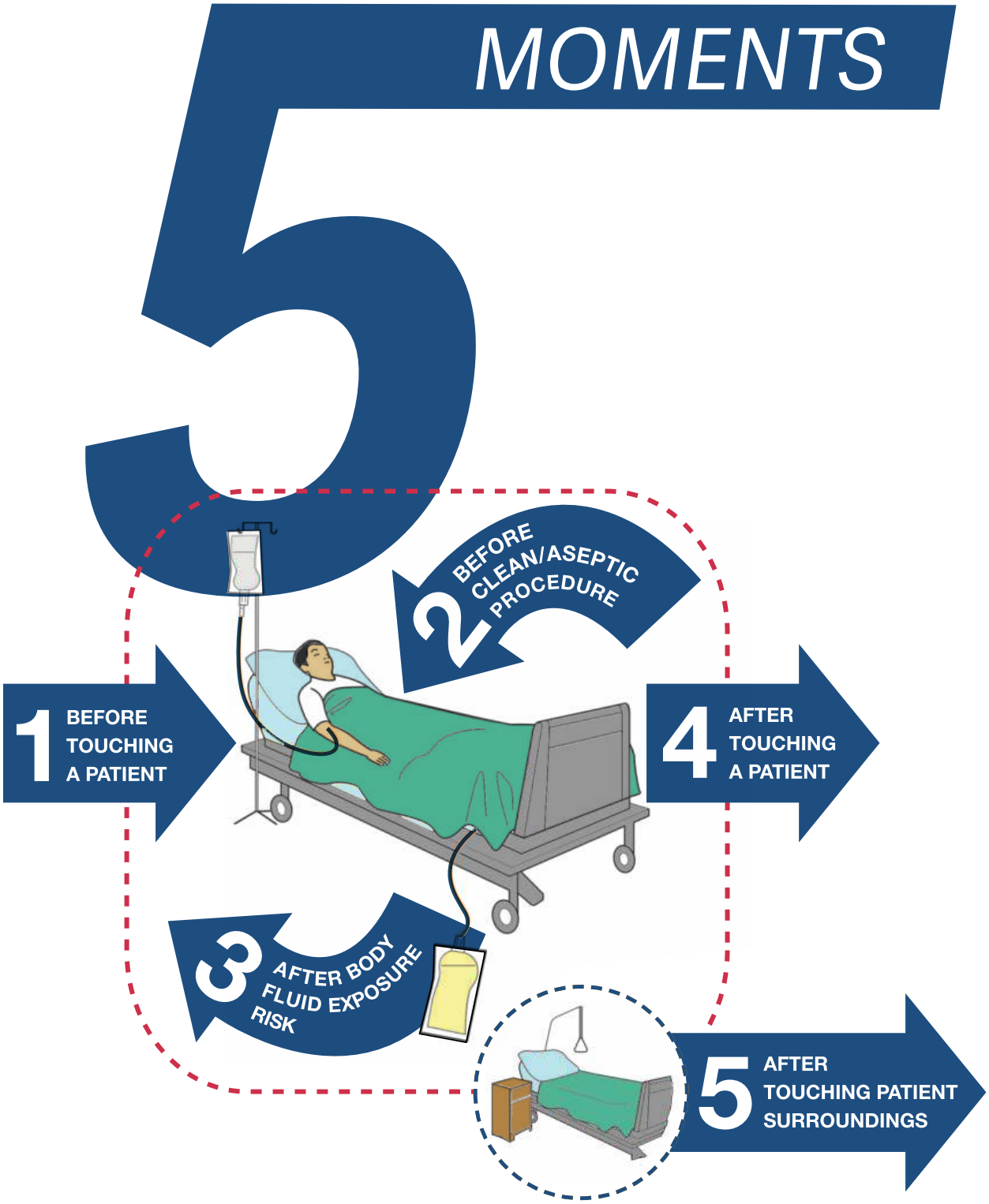
For normal hand decontamination, if hands are not obviously dirty, in the clinical scenarios outlined below, apply an Alcohol-Based Hand Rub (ABHR). Alternatively, wash your hands with water and antibacterial soap:

- Prior to speaking with patients directly
- Prior to putting on sterile gloves, during the central intravascular catheter insertion process
- Prior to implanting peripheral vascular catheters, indwelling urinary catheters, or other invasive devices that don't need surgery
- Following physical touch with a patient's unbroken skin (during procedures such as measuring a patient's blood pressure or pulse)
- Following touch with mucosal membranes, nonintact skin, bodily fluids or excretions, and wound dressings (if hands are not visibly soiled)[10]
- Moving a patient during patient care from a contaminated body site to a clean site following interaction with inanimate things (such as medical equipment)[10]
- Following glove removal [10]

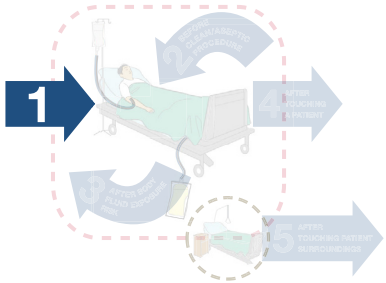
:

Five Moments for Hand Hygiene

Figure 2.7 **WHO recommended 5 moments for Hand Hygiene** [11] (Image source: WHO)



The 5 Moments for Hand Hygiene[2, 12, 13, 14, 15, 16]

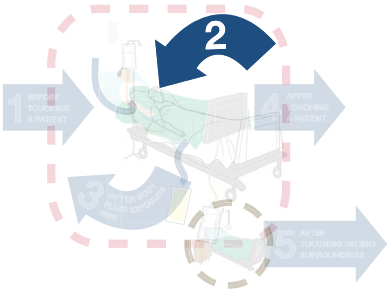


Moment 1 – Before touching a patient

WHEN: Perform hand hygiene on entering the patient zone before touching the patient

WHY: To protect the patient against acquiring foreign organisms from the hands of the HCW

Indication	Examples
Touching a patient in any way:	Allied health interventions, hand shaking, helping a patient move, and touching any medical equipment that is attached to the patient (such as an IV pump or an indwelling catheter)
Any personal care activities:	Grooming, hair combing, bathing, and putting on personal accessories like spectacles
Any non-invasive observations	Using ECG electrodes, palpating the abdomen, checking the patient's temperature, pulse rate, blood pressure, oxygen saturation, or other vital signs
Any non-invasive treatment:	Putting on braces or slings, using an oxygen mask or nasal cannula, and urinary incontinence management devices (including external catheterization with a condom sheath)
Preparation and administration of oral and nebulised medications:	Oral medications, nebulised medications
Oral care and feeding:	Feeding a patient, brushing teeth or dentures



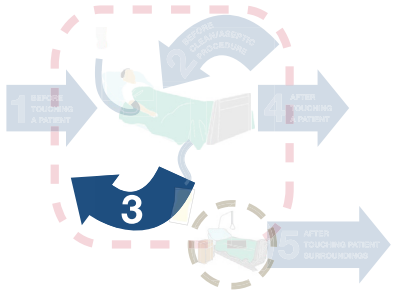
Moment 2 – Before undertaking a procedure

WHEN: Just prior to a surgery. Nothing in the patient's surroundings should be touched after performing hand hygiene and before the procedure

WHY: To shield the patient from potential organisms — including their own —entering their own body while performing the procedure

Indication	Examples
Insertion of a needle into a patient's skin, or into an invasive medical device:	Venepuncture, blood glucose level, arterial blood gas, subcutaneous or intramuscular injections, IV flush.
Aseptic procedures encompassing the preparation, administration of medications delivered through invasive medical devices:	IV medication, nasogastric tube feeds, percutaneous endoscopic gastrostomy feeds, baby NG/gavage feeds, set up of a dressing trolley.
Administration of medications that come into direct contact with mucous membranes:	Eye drop instillation, suppository insertion, vaginal pessary insertion

Indication	Examples
Manipulation of an invasive medical device:	Procedures involving a tracheostomy, endotracheal tube, nasopharyngeal airway devices, urinary catheter, ileostomy/colostomy, wound drains, vascular access systems, invasive monitoring devices, PEG tubes, NG tubes, secretory aspiration, and urinary catheterization.
Delivery of patient care interventions, including assessments, treatments, and procedures, that involve contact with compromised skin integrity (non-intact skin) or mucosal surfaces (non-intact mucous membranes):	Dressings, burn treatments, operations, digital rectal exams, invasive gynecological and obstetrical exams, and digital palate evaluations for newborns.

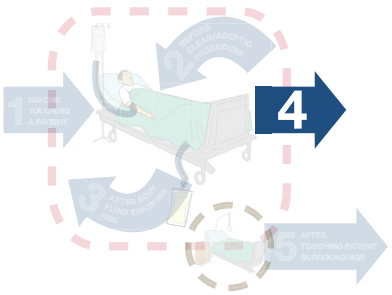


Moment 3 – After a procedure or body fluid exposure risk

WHEN: immediately after a procedure or potential body fluid exposure. Contaminated gloves can transfer germs during removal

WHY: To prevent the spread of possible pathogens from the patient to Healthcare worker and the surrounding areas of the healthcare facility

Indication	Examples
After any procedure:	See Moment 2
After any potential body fluid exposure:	➔ Contact with used specimen jars or pathology samples; contact with a bedpan or urine bottle that has been used; contact with sputum, either directly or indirectly through a cup or tissue; cleaning dentures; and cleaning up spills of blood, feces, urine, or vomit from the patient's surroundings after touching the exterior of a drainage tube or bottle ➔ Blood, saliva, mucous, semen, tears, wax, breast milk, colostrum, urine, feces, vomitus, pleural fluid, cerebral fluid, ascites fluid, lochia, meconium, pus, bone marrow, bile, and organic body samples, such as biopsy and cell samples, are among the substances that can come into contact with oneself

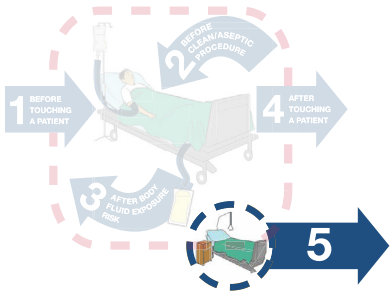


Moment 4 – After touching a patient

WHEN: Following patient contact. Before you leave the patient zone, wash your hands

WHY: to prevent pathogens from contaminating you or the hospitals' surrounding area

Indication	Examples
After Moment 1, unless there has been a possible contact with bodily fluids:	See Moment 1 and 2



Moment 5 – After Touching a Patient's Surroundings

WHEN: Even if the patient hasn't been touched, wash your hands after handling their belongings. Always wash your hands before leaving a patient's room

WHY: To prevent possible pathogens in the patient's surroundings from contaminating you and the adjacent areas of the hospital

Indication	Examples
If the patient has not been touched, following contact with their immediate environment:	The surroundings of the patient include the bed, bedrails, linen, table, bedside chart, bedside locker, light switches, call bell, TV remote control, personal belongings (such as books and mobility aids), chair, foot stool, and other items.

Table 2.2: Agents commonly used for hand hygiene[2, 9, 14, 17]

Alcohol Based Hand Rubs (ABHR)	• Hospital-grade ABHR can be found as low viscosity rinses, gels, and foams • The majority of alcohol-based hand antiseptics contain ethanol, n-propanol, iso-propanol, or a mixture of these substances • When your hands are not obviously dirty, it is best to utilize ABHR as it is a more effective way than using soap and water to wash your hands • Properties of alcohol come from its ability to denature proteins • Alcohols have excellent bactericidal, virucidal and fungicidal activity and are the most rapidly active of all agents used in hand disinfection • ABHR having 70–90% alcohol concentration should be used, for approximately 20–30 seconds with approximately 3–5 ml
Chlorhexidine gluconate	• Chlorhexidine's antibacterial action is probably caused by the compound adhering to and then disrupting cytoplasmic membranes, which causes the contents of cells to precipitate out • It is most effective against gram-positive bacteria, with some activity against gram-negative bacteria and fungi. However, its effectiveness against tuberculosis-causing bacteria (tubercle bacilli) is minimal • Chlorhexidine offers a significant advantage: it has residual activity. This means it continues to kill germs on the skin for a certain period even after application • 4% Chlorhexidine Gluconate detergent (CHG) is advised
Antimicrobial soap	• A concentration of antiseptic substance in soap (detergent) that is high enough to render microorganisms inactive and/or momentarily inhibit their growth • The routine use of antimicrobial soaps for hand hygiene is not necessary • When ABHR is not available, antimicrobial soap is an appropriate replacement
Plain soaps and water	• Sodium or potassium hydroxide, together with esterified fatty acids, are ingredients in detergent-based products called soaps • The cleaning action of these agents is due to their detergent properties. These properties facilitate the removal of lipids (fats), dirt, soil, and various organic matter from the hands • Although handwashing with basic soap can get rid of temporarily adhering loose bacteria, plain soaps have little to no antimicrobial activity • Washing for 30 seconds reduces the bacterial load from 1.8 to 2.8 $\log_{10}$

Hand-Hygiene Technique[18]

There are mainly two types of hand hygiene:

1. **Hygienic hand scrubs or hand washing:** Applying an aseptic hand wash or hand rub to the hands to lessen transient microflora without necessarily altering the skin's natural flora. During standard patient care, this is carried out

2. **Surgical hand asepsis:** A presurgical procedure to remove transient flora and minimize resident flora that is carried out with an aseptic scrub or antiseptic soap

Figure 2.8 **Basic Steps of Hand Hygiene with soap and ABHR [2]** (Image source: WHO)

Surgical hand antisepsis

Surgical hand antisepsis is the standard care prior to any surgical procedure. [2, 18, 19] It is a process that medical professionals use to remove or destroy microorganisms on their hands, nails, and forearms. It is performed before donning sterile attire and starting invasive procedures. The goal is to reduce the risk of surgical site infections (SSIs) in patients.[2]

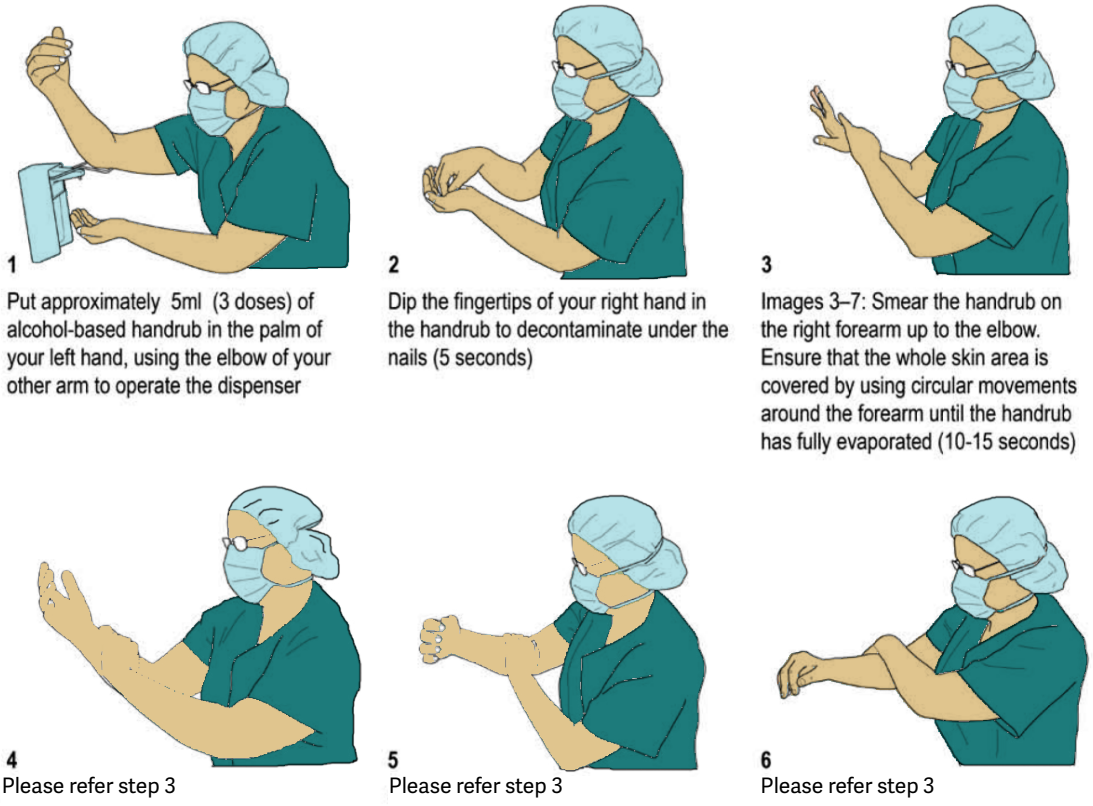
The recommendations are:

- To use sinks with minimal risk of splashes
- Prior to surgical hand washing, hands that are obviously soiled should be cleaned with soap and water. Use a nail cleaner under running water to get rid of any debris under your fingernails. Surgical hand wash/ scrub can be performed using either an antimicrobial soap solution or an alcohol-based hand rub with persistent activity
- When performing hand scrub using antimicrobial soap solution, scrub hands and forearms for a duration of two to six minutes, until slightly above the elbow
- Dry hands and arms using a sterile towel. Then don the gloves

Steps before starting surgical hand preparation.[20]

- When cleaning your hands, keep your nails short and pay attention to them because most bacteria on hands originate from under the nails
- Do not wear artificial nails or nail polish
- Take off all jewellery (watches, bracelets, and rings) before going into the operating room
- Wash hands and arms with a non-medicated soap before entering the operating theatre area or if hands are visibly soiled
- Clean subungual areas with a nail file

Figure 2.9 **Steps of Surgical Hand Antisepsis** (Image source: WHO)



7

Please refer step 3

8

Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your right hand, using the elbow of your other arm to operate the dispenser

9

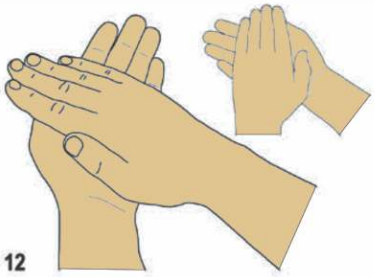
Dip the fingertips of your left hand in the handrub to decontaminate under the nails (5 seconds)

10

Smear the handrub on the left forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds)

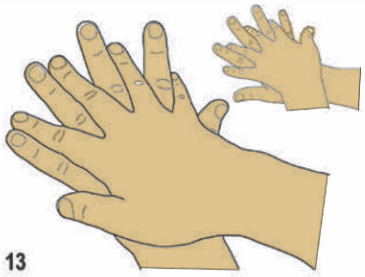
11

Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the distributor. Rub both hands at the same time up to the wrists, and ensure that all the steps re-presented in Images 12-17 are followed (20-30 seconds)



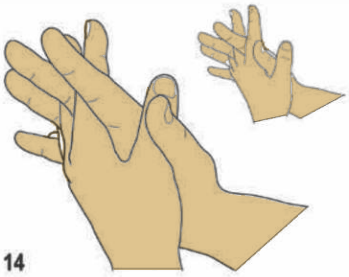
12

Cover the whole surface of the hands up to the wrist with alcohol-based han-drub, rubbing palm against palm with a rotating movement



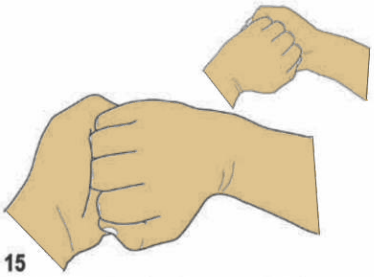
13

Rub the back of the left hand, including the wrist, moving the right palm back and forth, and vice-versa



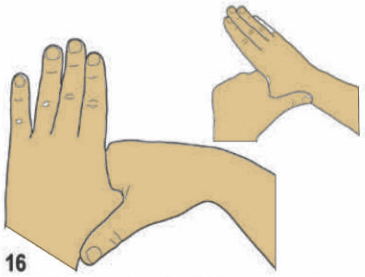
14

Rub palm against palm back and forth with fingers interlinked



15

Rub the back of the fingers by holding them in the palm of the other hand with a sideways back and forth movement



16

Rub the thumb of the left hand by rota-ting it in the clasped palm of the right hand and vice versa

17

When the hands are dry, sterile surgical clothing and gloves can be donned

Importance of Hand drying[18, 21]

- Drying hands properly is essential for regular handwashing since germs may more easily spread and acquire on wet hands[2]
- This increased risk may be a factor in patient injury, environmental contamination, cross-infections, and occupational contact dermatitis among healthcare professionals. As a result, thorough hand drying is essential to the hand hygiene protocol
- The importance of hand drying comprises not only removing moisture from the hands but also creating mechanical friction, which lowers the bacterial load and, consequently, the spread of pathogens
- Hands cleaned and dried with paper towels, cloth towels, and warm air dryers are standard practices. Towel sharing and reuse should be avoided due to the possibility of cross-infection
- When using clean or disposable towels, it is crucial to gently pat the skin instead of rubbing it to prevent skin from cracking[2]

Figure 2.10 **Hand drying using clean towel** (Image source: Initial.com/blog)

Hand hygiene-related skin reactions[2]: Hand hygiene-related skin reactions can occur on healthcare workers' hands due to the requirement for frequent hand hygiene during patient care.

There are two major types of skin reactions associated with hand hygiene:

Irritant contact dermatitis

- Irritant contact dermatitis is extremely common and is caused by frequent use of hand hygiene products
- Includes symptoms such as dryness, irritation, itching and in some cases even cracking and bleeding
- Irritant contact dermatitis is more commonly reported with iodophors

Allergic contact dermatitis

- It's uncommon and indicates an allergy to a component of a hand sanitization product
- Additionally, the severity and localization of allergic contact dermatitis symptoms might vary to a generalized form

Figure 2.11a **Irritant Contact Dermatitis (ICD)** (Image source: Dermatology and skin clinic, uk)

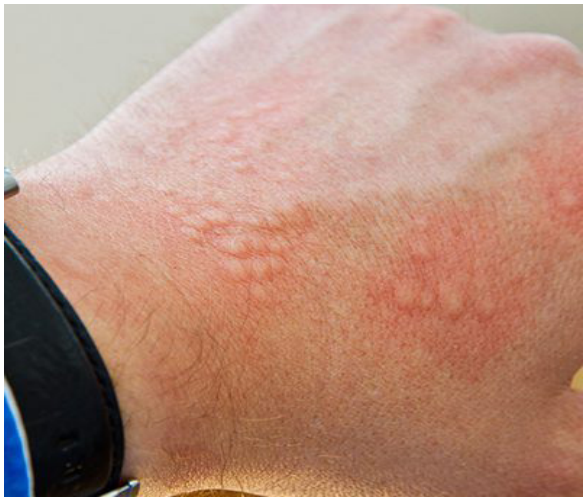
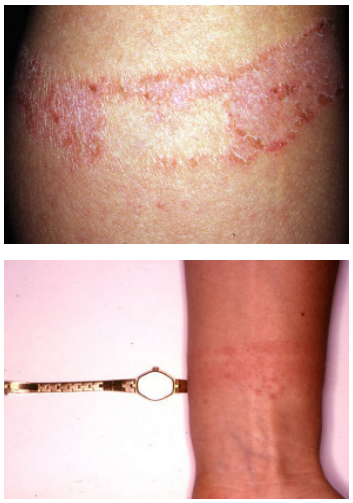


Figure 2.11b **Allergic Contact Dermatitis (ACD)** (Image source: dernNetnz.org)



Avoid these practices to decrease the risk of dermatitis or skin irritation[2]:

- Not only is it superfluous to often wash your hands with soap and water before or after using an alcohol-based product, but it can also cause dermatitis
- Avoid washing your hands in extremely hot water since this raises the risk of skin injury
- Putting on gloves while damp after washing or using alcohol raises the possibility of irritating the skin
- It's crucial to pat the skin rather than rub it while using fresh or disposable towels to prevent cracking

Hand care[2]

- Regularly use an emollient hand cream to shield skin from the drying effects of hand washing products
- Healthcare workers must use items approved by the Health Care Facility since products such as liquid soaps, hand lotions, ointments, or creams may include components that cause contact allergies
- Apply water-resistant occlusive dressings to wounds and abrasions, and replace them as needed
- If one has skin issues like exudative lesions or weeping dermatitis, consult a doctor and stay away from patient care until the issue is resolved[22]

Gloves[2, 18]

- Gloves should not be worn in place of hand washing; hand cleaning and hygiene should be done beforehand
- When handling blood or other potentially infectious materials, mucous membranes, or non-intact skin could occur, wear gloves
- Once you've attended to a patient, take off your gloves. When caring for multiple patients, never wear the same pair of gloves
- When providing patient care, remove your gloves if you're going from a contaminated body spot to a clean one for the same patient

WHO Multimodal Hand Hygiene Improvement Strategy[2]

It includes a set of tools designed to make the implementation of each component easier as well as an implementation guide. The multimodal strategy comprises five components that should be executed concurrently.

Table 2.3: Basic requirements for implementation [23, 24, 25]

Multimodal strategy	Minimum criteria for implementation
Alcohol-based handrub	• Alcohol-based handrub bottles placed at each ward's point of care or distributed to personnel
 System Change Access to safe continuous water supply and towels	• At least one sink for every ten beds • Each basin should have soap and new towels accessible.
 Training and education	• All personnel participating in the testing phase receive training. • A short-, medium-, and long-term training updating program is established.
 Evaluation and feedback	• Two observational monitoring periods are conducted.
 Reminders and communication	• All test wards (e.g., patient rooms, staff areas, out-patient/ambulatory departments) have "How to" and "5 Moments" posters up.
 Institutional safety climate	• A clear commitment from the Chief Executive Officer, Chief Medical Officer/Medical Superintendent, and Chief Nurse to encourage improved hand hygiene (e.g., announcements and/or official letters to workers)

Compliance of hand hygiene by Healthcare Workers

The compliance with hand hygiene guidelines is a significant challenge, particularly in low resource settings, where inadequate resources, overcrowded facilities, varied levels of education among Healthcare Workers (HCWs), and relatives of patients pose considerable difficulties. Research indicates a wide range of hand hygiene compliance rates among HCWs in Indian hospitals. Factors associated with non-compliance included high workload, lack of knowledge about guidelines, and the perceived notion that gloves replace the need for hand hygiene.

In addition to HCWs, the role of patient's relatives in Infection Control is significant, particularly in Indian scenario where family members often participate in patient care. However, studies indicate lower hand hygiene compliance rates among this group. A survey by Nagaraja et al. showed a compliance rate of only 29% among patients' relatives. This lower rate could be attributed to factors such as lack of awareness, cultural beliefs, and absence of strict guidelines.

Addressing these issues demands a multifaceted approach. Firstly, education programs for HCWs and patients relatives should be implemented. These programs should focus on the importance of hand hygiene, the correct technique, and the consequences of non-compliance.

Moreover, the role of hospital leadership is crucial in promoting hand hygiene. Hospital management should ensure the availability of necessary resources for hand hygiene, such as hand sanitizers and soap, especially in critical areas like ICUs and OTs. Encouraging a positive culture around hand hygiene is also essential, possibly through strategies such as role modelling, rewards, and reminders.

While the WHO's 'My 5 Moments for Hand Hygiene' approach has been successful globally, a contextual adaptation for Indian settings might be beneficial.[2] For instance, additional 'moments' could be included to account for situations specific to India, like family members feeding patients.

Evidence from Systematic Review: Hand Hygiene

- Hand hygiene compliance among healthcare workers is a critical factor in preventing healthcare-associated infections and controlling the spread of pathogens during the COVID-19 pandemic.[26-29] Studies conducted in various healthcare settings have consistently shown that proper hand hygiene practices, including handwashing with soap and water or using alcohol-based hand sanitizers, significantly reduce the risk of infections[21, 26, 28, 30]

- Although hand hygiene is an important preventive measure, it alone is insufficient to control the spread of SARS-CoV-2. Additional infection control strategies, such as the use of Personal Protective Equipment (PPE) like N95 respirators, double gloves, gowns, goggles, alcohol-based hand sanitizers, and soap, are recommended in healthcare settings[30]

- Several interventions, such as hand hygiene audits, feedback, and education, have been found effective in improving hand hygiene compliance rates among healthcare workers.[14] Implementing multimodal hygiene interventions, including the use of guidelines, behavioural recommendations, and hand hygiene education, has shown positive results in enhancing overall compliance[2, 21]

- Effective hand drying after handwashing is crucial in maintaining skin integrity and optimizing the removal of potentially pathogenic microorganisms from hands. Dry hands are safer, as wet hands pose an infection risk by increasing the potential for microbial transmission and environmental contamination[2, 21]

- The adoption of the standardized World Health Organization (WHO) Hand Hygiene Self-Assessment Framework (HHSAF) assists in evaluating hand hygiene practices and identifying areas for improvement in Healthcare Facilities[32]

- Furthermore, the WHO guidelines, while valuable, may not fully address all barriers to hand hygiene within specific healthcare systems. Utilizing the SEIPS model in interviews has been shown to be beneficial in identifying additional areas of improvement and implementation gaps that are institution-specific[32]

- In conclusion, evidence from these studies highlights the importance of hand hygiene compliance, the need for additional infection control strategies, the role of WHO guidelines and the HHSAF in assessing hand hygiene practices, and the significance of effective hand drying in reducing the risk of infections in healthcare settings [31]

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Contents of this Chapter

Picture Credit: AIIMS, New Delhi

Chapter 3

Respiratory Hygiene/ Cough Etiquette

Respiratory Hygiene/ Cough Etiquette

Simple steps like covering coughs and sneezes and washing hands regularly are well-established practices for keeping ourselves and others healthy. During public health emergencies, like the COVID-19 pandemic or any disease outbreak, these habits become even more important. By following good respiratory hygiene and cough etiquette, we can significantly reduce the spread of illness and protect our communities.

Respiratory illnesses pose a significant threat to global health, causing millions of people to get sick, become disabled, and even die each year. Worldwide, it's estimated that these infections cause over four million deaths annually. Influenza is a particularly serious respiratory illness, contributing an additional 250,000 to 500,000 deaths each year. These illnesses also have a major economic impact, costing an estimated $71 to $167 billion annually.[1]

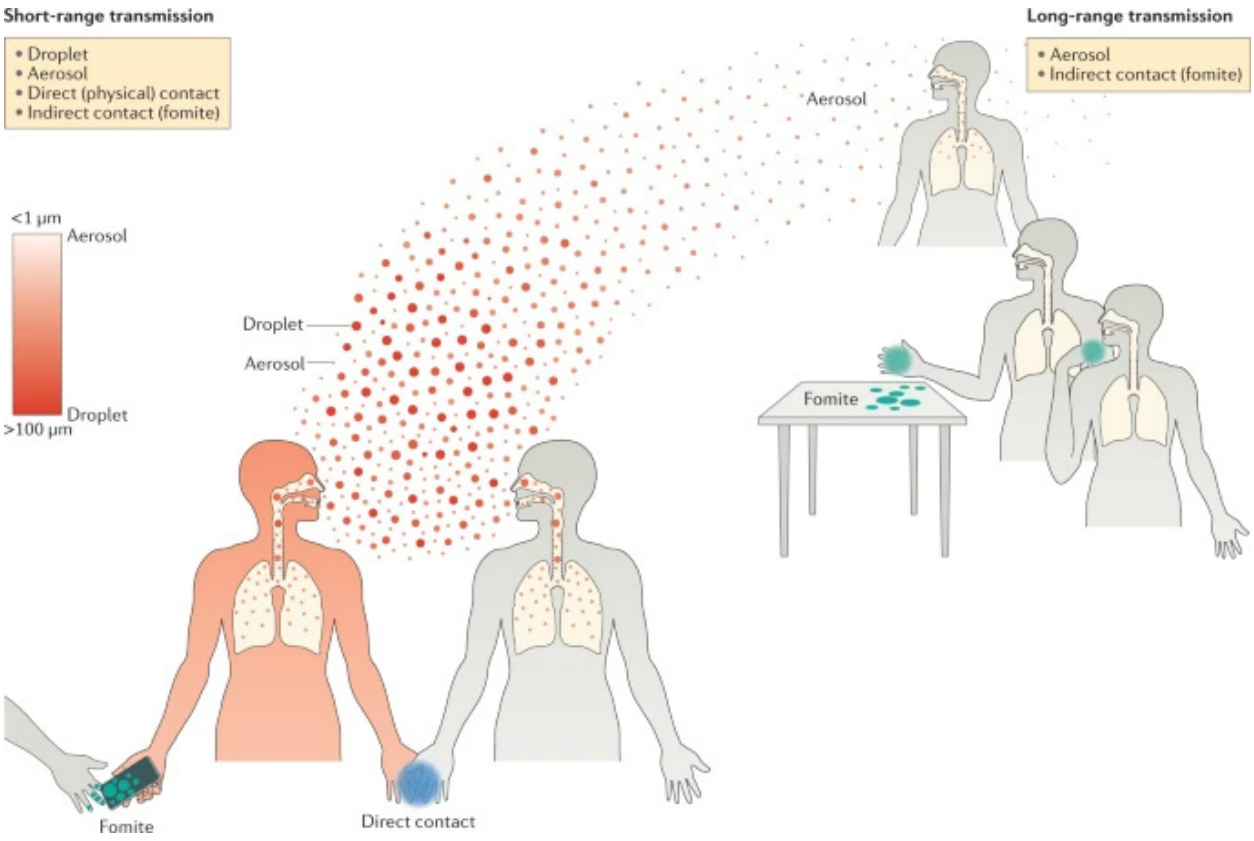
Practicing routine and thorough hygiene, including handwashing, mask-wearing, and managing respiratory symptoms, can prevent respiratory illnesses and reduce their global impact.[1] There are ways to fight back against respiratory illnesses without needing medicine. These are called non-pharmaceutical interventions, and they're very important for keeping everyone healthy.[2] Among these, Respiratory Hygiene Behaviours (RHBs) are highlighted, with a primary focus on essential practices like hand hygiene and proper cough etiquette, which involves covering coughs and sneezes appropriately.[3]

The Significance of Respiratory Hygiene and Cough Etiquette in Public Health

Preventing the spread of respiratory illnesses like influenza and the common cold relies heavily on good hygiene practices. These practices, encompassing both how we care for our respiratory systems and how we manage coughs and sneezes, are collectively known as respiratory hygiene and cough etiquette. When someone infected with a respiratory virus coughs or sneezes, droplets containing the virus are expelled. These droplets can travel a short distance through the air and potentially infect others who come into direct contact with them, or indirectly by touching a contaminated surface and then their face. Direct contact, such as shaking hands, can also facilitate the spread of viruses between individuals. Additionally, these respiratory droplets can linger for a short duration on different surfaces in our surroundings, including bed rails, doorknobs, wheelchairs, and patient care equipment, increasing the risk of transmission when touched by others. This persistence of droplets on surfaces creates a potential pathway for the pathogens to spread from an infected person to others.

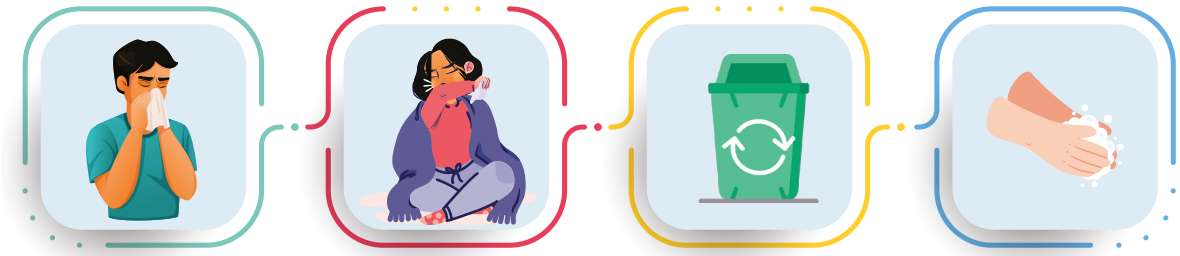
Signs and symptoms of respiratory infection can vary but often include coughing, feeling congested, runny nose (also known as rhinorrhea) or an overall increase in mucus production in the airways. Although fever is present in many respiratory infections, absence of fever in the context of other respiratory symptoms does not necessarily exclude a respiratory infection. However, the consistent practice of proper respiratory hygiene and cough etiquette can significantly decrease the spread of these infectious agents.[3–6]

Figure 3.1 **A person exhales various-sized respiratory droplets, with some remaining airborne. A nearby individual may inhale these, highlighting the possibility of disease spread via these droplets.**
(Image source: Nature Reviews Microbiology)



Simple yet powerful tools like respiratory hygiene and cough etiquette are at the forefront of preventing the spread of respiratory illnesses. These practices are considered a part of Standard Precautions, particularly relevant for individuals experiencing symptoms of a respiratory illness with a focus on containing respiratory secretions and minimizing their spread. By adopting proper respiratory hygiene

Figure 3.2 **Respiratory hygiene/cough etiquettes**



During a cough or sneeze, cover your mouth and nose with a disposable tissue or handkerchief

You can also cover your nose with your bent elbow to minimize the spread of the pathogen

After using the tissue dispose off it in the waste bin

Decontaminate your hands using soap and water or ABHR

and cough etiquette, such as covering your mouth and nose with a tissue when you cough or sneeze or into the crook of your elbow, individuals can help minimize the spread of respiratory illnesses to others. The implementation of these straightforward yet highly effective measures has a demonstrably positive impact on curbing the spread of respiratory illnesses.[7, 8]

Recommended steps for an infected individual[3-13]

For an infected individual, consistent adherence to respiratory hygiene and cough etiquette represents a cornerstone in preventing the transmission of respiratory illnesses to others. Here are the steps they should follow:

- **Use tissues**: Always keep tissues handy and use them to effectively contain your cough or sneeze by covering your nose and mouth. This helps to trap respiratory droplets containing infectious particles
- **Dispose off tissues properly:** Following use, promptly discard the tissue in a lined trash bin. Avoid leaving used tissues on surfaces or in open spaces
- **Use Elbow:** In the absence of a tissue, cough or sneeze into the crook of your elbow, ensuring your elbow is bent towards your body. This can help contain the droplets and prevent them from spreading into the air
- **Avoid Touching Face:** Avoid direct contact with your face, particularly the mouth, nose or eyes, as these are common entry points for respiratory pathogens that may have contaminated your hands
- **Hand Hygiene:** Frequent handwashing with soap and water for at least 20 seconds is essential, particularly crucial after coughing, sneezing, or blowing your nose. In situations where soap and water are unavailable, an alcohol-based hand sanitizer with a minimum concentration of 60% alcohol can be used as an alternative
- **Wear a Mask:** If you need to be around others, wear a mask to prevent respiratory droplets from spreading into the air. Masks can also protect others from potential exposure to infectious particles
- **Maintain Distance:** Maintain a safe distance of atleast six feet from others, particularly in crowded settings or when interacting with people who are not part of your immediate household
- **Isolate Yourself:** If you are feeling unwell with respiratory symptoms,it is essential to self-isolate, which involves staying home and minimizing contact with others, to prevent further transmission
- **Clean and Disinfect:** Frequent cleaning and disinfection of frequently touched surfaces and objects, such as doorknobs, light switches, and electronic devices, are crucial steps in minimizing the risk of indirect transmission of respiratory pathogens

Recommendations for Healthcare settings[3]

Respiratory hygiene and cough etiquette are vital infection control measures, particularly in healthcare settings, to prevent the transmission of respiratory infections like influenza. These practices should be implemented as part of Standard Precautions when interacting with potentially infected individuals. Here are the key recommendations:

- **Adequate and proper ventilation:** Enhancing ventilation, or the introduction of fresh outdoor air, is a significant strategy for reducing indoor air pollutant concentrations, including potential airborne viruses. Proper ventilation decreases airborne virus concentration and limits surface contamination by removing virus particles before they settle[14]
- **Visual Alerts:** Healthcare facilities can utilize prominent visual alerts at entrances to encourage patients and visitors to disclose any symptoms of respiratory infection to healthcare personnel and to practice respiratory hygiene and cough etiquette
- **Respiratory Hygiene/Cough Etiquette:** For individuals with signs of respiratory infections, effective respiratory hygiene involves the use of a tissue to cover the mouth and nose during coughs and sneezes. Used tissues should be disposed of in waste receptacles, followed by proper hand hygiene

- **Materials Availability:** To promote a culture of good hygiene and minimize the risk of infection transmission, healthcare facilities can implement several strategies. These may include readily available tissues for patients and staff, conveniently located dispensers for alcohol-based hand sanitizer, and the use of no-touch receptacles for safe and hygienic tissue disposal. For locations with sinks, supplies for handwashing should be consistently available
- **Spatial separation:** Maintaining physical distance from individuals with respiratory infections is essential to prevent exposure and transmission of respiratory pathogens. Additionally, maintaining appropriate patient flow and minimizing overcrowding in patient care areas are essential measures for curbing the spread

  By incorporating these measures, healthcare settings can effectively minimize the risk of transmitting respiratory infections and protect both healthcare personnel and patients

Respiratory Hygiene in case of a Public Health Emergency[13, 15]

Respiratory hygiene and cough etiquette are of utmost importance during a pandemic, especially one involving a highly contagious respiratory virus like COVID-19. By adhering to these essential respiratory hygiene and cough etiquette protocols, we can significantly contribute to mitigating the spread of the virus. This collective effort helps to lessen the strain on healthcare systems, safeguarding public health. Here's why they are vital:

- **Virus Containment:** Transmission of respiratory viruses and some bacteriae occurs primarily through the inhalation of respiratory droplets expelled by an infected person when coughing, sneezing, talking, or even breathing. By following respiratory hygiene and cough etiquette, infected individuals can limit the release of infectious droplets, thereby reducing the chances of infecting others
- **Asymptomatic Transmission:** A significant concern is the potential for asymptomatic or presymptomatic individuals to unknowingly spread the virus. Practicing cough etiquette and wearing masks can help asymptomatic carriers prevent unknowingly spreading the virus to others
- **Community Protection:** By adhering to respiratory hygiene and cough etiquette, individuals protect those around them, especially vulnerable populations, including older adults and individuals with pre-existing health conditions, who are more vulnerable to experiencing serious complications
- **Public Health Measures:** Effective control of respiratory illness transmission relies on a multi-layered strategy. Respiratory hygiene and cough etiquette, alongside measures like mask-wearing, physical distancing, and hand hygiene, work in synergy to create a robust defense against the spread of pathogens
- **Utilizing Information Technology and Mass Media:** Information technology and mass media, along with IEC (Information, Education, and Communication) materials, are powerful tools for promoting behavior change and encouraging good hygiene practices. They can disseminate critical information, guidelines, and awareness campaigns to reach a broader audience and reinforce the importance of respiratory hygiene during a Public Health Emergency
- **Preventing Healthcare Transmission:** Healthcare settings are high-risk environments for virus transmission. Consistent adherence to respiratory hygiene and cough etiquette protocols plays a vital role in safeguarding both healthcare workers and patients. By minimizing the spread of germs, these practices help to prevent hospital-acquired infections and ensure healthcare facilities can maintain their capacity to deliver essential medical services
- **Flattening the Curve:** By reducing the transmission rate through respiratory hygiene and cough etiquette, we can "flatten the curve," meaning a slower viral spread, which translates to a more manageable burden on healthcare infrastructure and personnel, ensuring better care for all patients

- **Pandemic Preparedness:** Emphasizing and adopting these etiquettes during a pandemic creates a culture of infection prevention and preparedness, setting a foundation for future pandemic response
- **Global Health Impact:** The widespread adoption of respiratory and cough etiquettes can have a global impact, preventing cross-border transmission and mitigating the pandemic's social, economic, and health consequences

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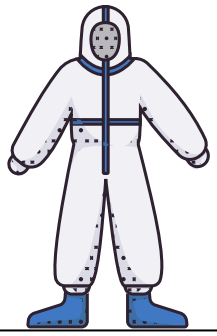
Contents of this Chapter

Picture Credit: AIIMS, New Delhi

Chapter 4

Personal Protective Equipment

Personal Protective Equipment

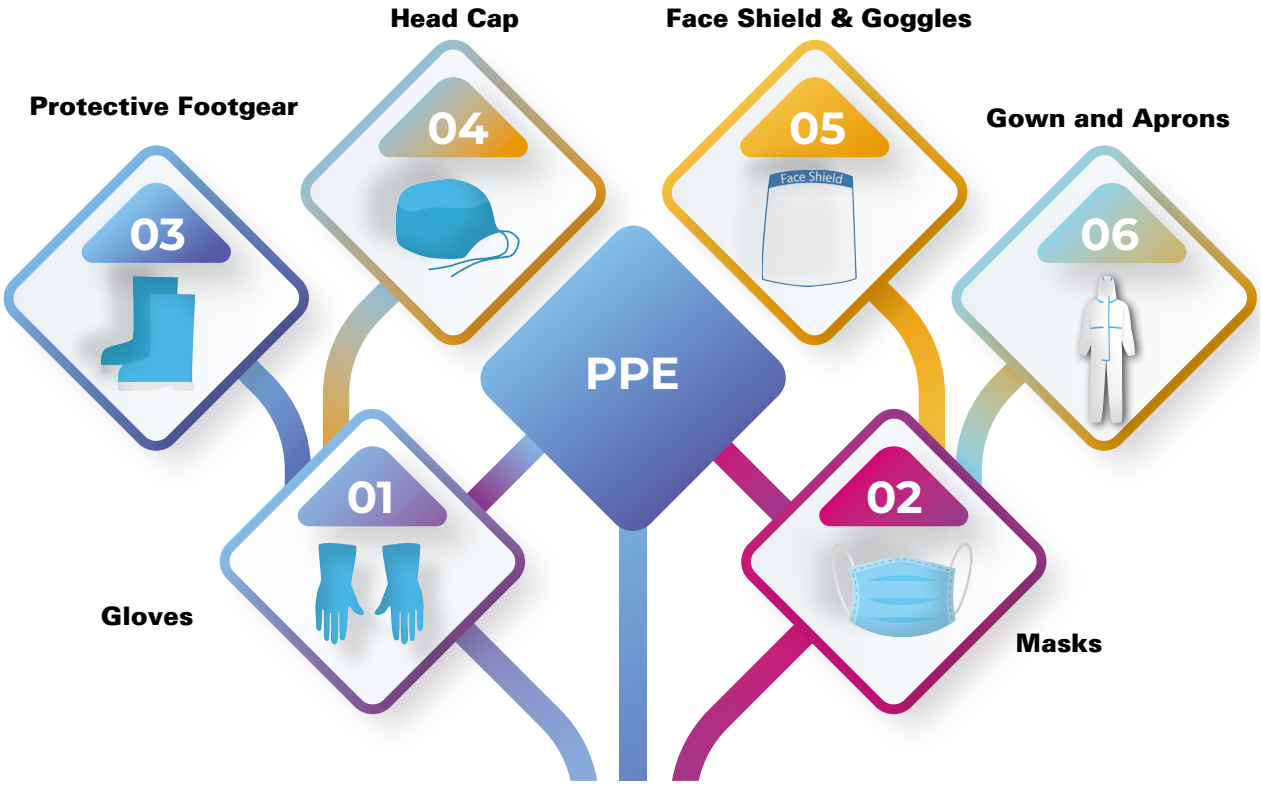


Personal protective equipment, or PPE, as defined by the Occupational Safety and Health Administration (OSHA) is *"specialized clothing or equipment, worn by an employee for protection against infectious materials."* PPE helps in breaking chain of infection transmission between patients and healthcare workers, thereby reducing the healthcare associated infections.

PPE's should be[1]

- Near to the point of use
- Properly stored in clean and dry area in order to prevent contamination, till period of expiry
- Used only once or as per manufacturers instruction
- Used only on single patient and disposed off properly as per prevailing practices/ regulations
- Properly decontaminated and reprocessed by a trained healthcare personnel in case of reusable items such as goggles, face shields etc.

Figure 4.1 Types of Personal Protective Equipment



Gloves

Personal Protective Equipment (PPE) encompasses a wide range of gear designed to protect workers from health and safety hazards. One of the essential components of PPE is gloves which are disposable, one-time-use coverings to protect the hands of healthcare providers.[2] They serve as a barrier against physical, chemical, biological, and other hazards that workers might encounter during their tasks.

Types of gloves

A. Based on material [3, 4, 5]

- Latex or NRL (natural rubber latex)
- Vinyl or polyvinyl chloride
- De-proteinised natural rubber latex (DPNRL) with most latex proteins removed
- Nitrile, i.e., nitrile butadiene rubber (NBR) or acrylonitrile-butadiene
- Polyvinyl chloride (PVC)
- Neoprene or chloroprene or polychloroprene

B. Based on use

- Clean, non-sterile gloves should be worn:
  - For examinations and non-surgical procedures
  - By HCWs with open skin wounds/lesions to handle items containing blood or bodily fluids
  - By HCWs having broken skin on hands
- Aseptic procedures must involve usage of sterile disposable gloves
- Heavy duty reusable gloves should be used for cleaning and decontamination of equipment, furniture and environmental surfaces

Table 4.1: Comparison between different types of gloves used in healthcare facilities[6]

Types of Gloves	Advantages	Disdvantages
Latex including DPNRL*	• Disposable • Impermeable • Good solvent resistance • Highly elastic, allows for a firm grip	• Allergic reaction • Chemically unstable and degrade and discolour swiftly. This may produce a residue that can be deposited on objects
Nitrile (acrylonitrile)	• Disposable • Do not deposit residue • Chemically stable • Provide impermeable barrier • Allow a firm grip • Enough to allow fine or detailed work	• Allergic reactions to nitrile has been reported by some HCWs • In some cases, may not fit tightly
Vinyl	• Disposable • Provide impermeable barrier between objects and human skin	• Loose fitting and unsuitable for procedures that require manual dexterity
Neoprene	• Not only are these gloves latex-free, but they also mimic the dexterity and feel of latex, making them a go-to option for surgeries and other procedures requiring both sensitivity and a latex-free environment	• More expensive than natural rubber latex gloves

*De-proteinised natural rubber latex (DPNRL)

When should gloves be changed or removed?[4]

It is recommended that gloves should be changed promptly after use followed by immediate performance of hand hygiene. The following are the indications for changing gloves:

a. Following each use and at the end of each task

b. Immediately if heavily contaminated by blood or bodily fluids

c. After patient contact and fresh pair required for each patient contact

d. Between procedures on the same patient

e. When the gloves appear damaged (torn, ripped) or there's a chance they're punctured

f. Following exposure to cleaning products

g. When there is an indication for hand hygiene

Prompt removal of gloves followed by handwashing is recommended after each use in following situations:

a. Before touching clean items and surfaces

b. Prior to making contact with one's eyes, nose and mouth

c. Before examining another patient

d. As the first step in the removal of PPEs

Storage of gloves

Keeping glove boxes sealed is crucial to prevent contamination and damage. Once opened, gloves become vulnerable to germs and break down more easily if not stored properly.
To preserve the integrity, it is essential that gloves are stored away from sunlight, excessive heat, high humidity, and moisture. In addition, they must also be kept away from x-ray machines, high-intensity fluorescent light and ultraviolet light, and sources of ozone.[7]

Integrity of gloves

Be aware that lotions with oils (like mineral, lanolin, or coconut) and petroleum jelly can damage latex gloves, making them less effective at blocking germs. Stick to water-based or glycerin lotions instead – they won't weaken the gloves and are a safe choice if you need hand lotion. [7]

Make sure your hands are completely dry before putting on gloves. Wet alcohol rub can damage the gloves. Also, trim your fingernails and remove jewelry. They can trap germs and rip the gloves, even with tiny tears you can't see.

Donning of clean/non-sterile gloves [1,4,8]

1. Perform hand hygiene, before donning gloves, ensuring hands are completely dry
2. Remove gloves from the box
3. Only touch the outside of the glove, near the wrist opening
4. Advance the fingers into the glove and once the first glove is donned, do not touch with your ungloved hand
5. Pick up the second glove with your bare hand, but only touch the outside near the wrist opening
6. To avoid touching your forearm with your gloved fingers, turn the external surface of the glove (close to wrist) to be donned over the fingers of the gloved hand, and advance hand into the second glove
7. To prevent your gloved hand from touching your forearm, fold the cuff of the second glove inwards slightly. Then, use your gloved hand to reach inside and pull the second glove on
8. Once your gloves are on, keep your hands off anything that isn't directly related to what you're supposed to be doing with the gloves

Donning sterilized gloves - Open method [10]

1. Check the integrity of the external packaging and expiry date of gloves to ensure that gloves are not contaminated
2. Open the outer packaging and place the inner packet onto decontaminated and clean surface
3. Perform hand health assessment and decontamination

Figure 4.2 **Donning of Non-sterile gloves [9, 11]** **(Image source: Themisto)**

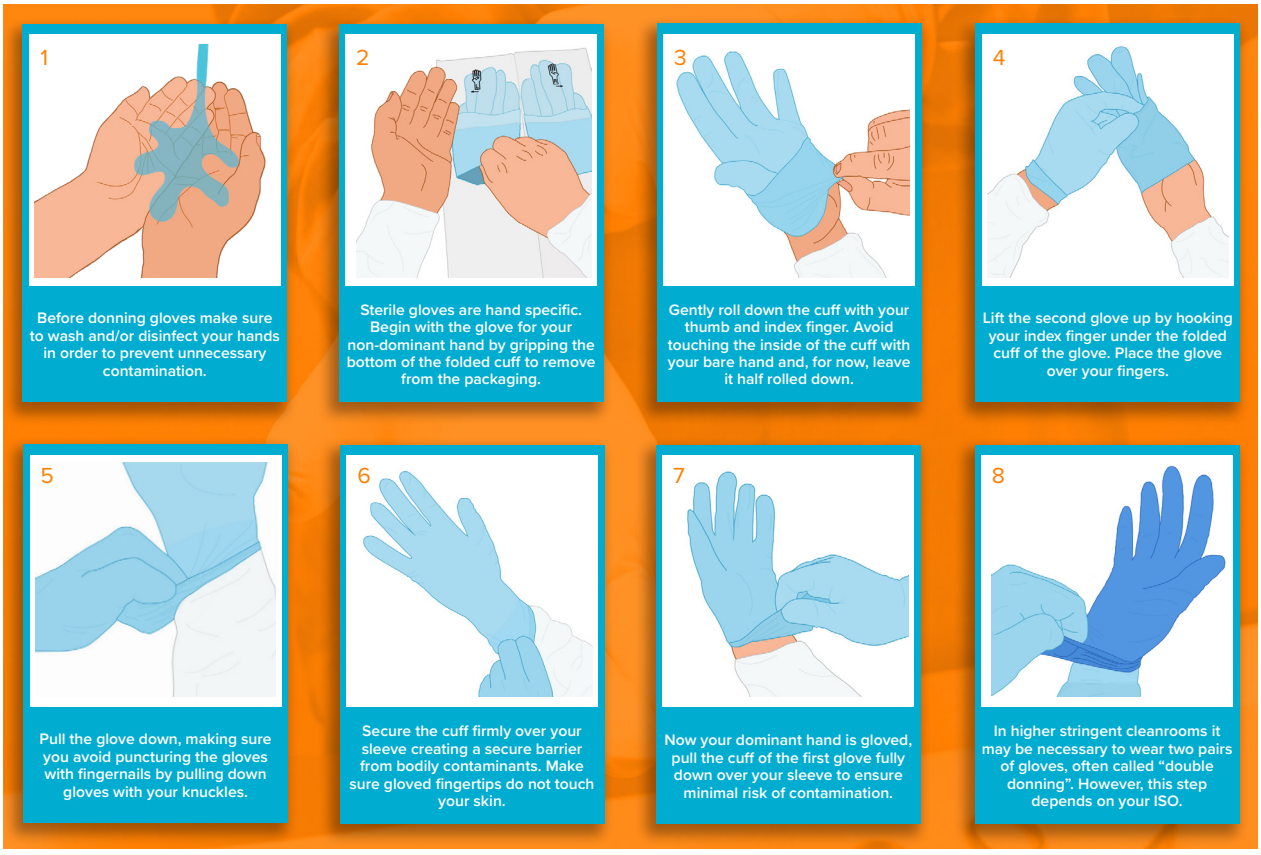
4. With decontaminated hands, open the inner packaging by placing your fingers under the folded paper edge. By doing this, you limit microorganism contact and transfer
5. The gloves should now be exposed with glove cuffs being nearest to the clinician. Use your thumb and index finger to carefully pick up the glove by the folded edge at the wrist. Advance the other hand into glove making sure the thumb is facing upwards and cuff remains folded over
6. Once you have this glove on, avoid touching the sterile surface of the glove with your bare hand. Again, this is to limit the transfer of microorganisms
7. For the second glove, reach in with the gloved hand, keeping your fingers tucked under the folded cuff. Slide your fingers in without touching the outside of the glove. In one smooth motion, pull the second glove onto your bare hand. Make sure your fingers and webbing feel comfortable, and adjust them if needed [11]
8. Unfold the cuff of the first glove by gently slipping fingers inside the fold. Avoid contact with ungloved surfaces

A second technique, the closed method, can be used when a sterile surgical gown is also being worn as part of the surgical antiseptic non-touch technique (ANTT). [11]

Donning sterilized gloves- Closed Method [12, 13, 14]

- When closed gloving, keep your hands inside the gown cuffs before gloving. Ask an assistant to open the outer packet of the gloves. (Remember to be careful and not touch the external wrapper of the gloves when taking the gloves and to keep hands inside the cuff at all times during the gowning and gloving procedure)
- Lay the glove packet flat on a clean, germ-free surface, with the finger section of the gloves facing you
- Hold the glove by the folded cuff with your non-dominant hand, making sure not to touch the exterior surface of the glove
- Insert your dominant hand into the glove without touching the outside of the glove

Figure 4.3 Donning of Sterilized gloves (Open method) [9] (Image source: Integrity Cleanroom, UK)



- Pull the glove onto your hand, ensuring that it covers your fingers, palm, and wrist completely. Do not let your ungloved hand touch the gloved hand at any point during this process
- Do the same thing again for the other glove. Use your left hand (already gloved) to pick up the right glove and place it on your right wrist
- Double up on sterile gloves! This is recommended when there's a high chance the gloves might tear or rip, and getting contaminated could be very dangerous
- Now with both hands covered you can attend to finer adjustment of both gloves without risk of contamination. Gently pull the glove sleaves down to remove gown folds

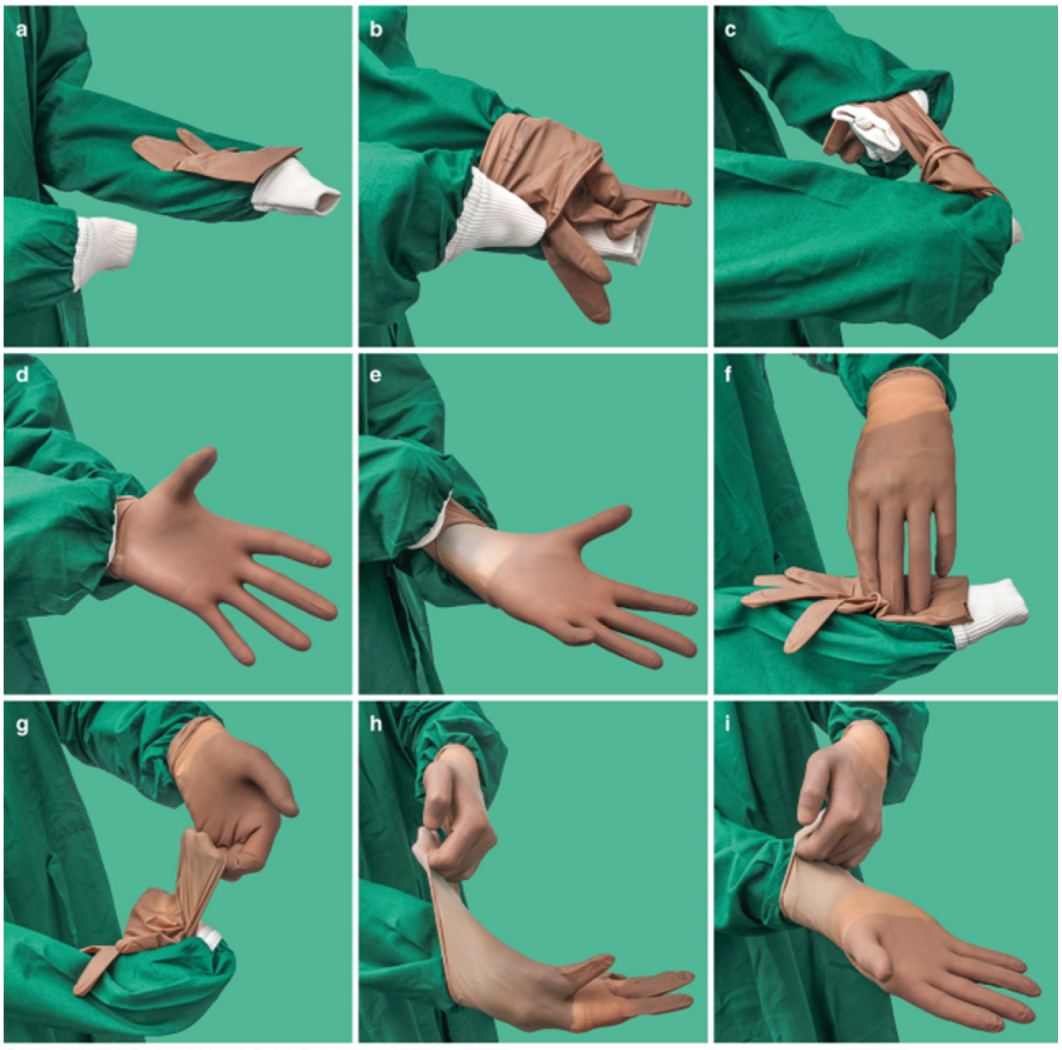
To prevent glove/gown separation ensure the following:

- Your gown sleeves are long enough not to restrict movement and drag the gown cuff up away from the glove
- Ensure that there is gown cuff present down to the base of your palm – adequate grip area for the glove to grip the gown
- Ensure that you have no glove cuff folds at the end of the glove

Doffing of Gloves [14]

1. Using the gloved hand, grip and lift the outside edge of the first glove cuff using the other hand – taking care not to touch the skin of the wrist or the hand
2. Peel off the first glove whilst turning it inside out
3. Keep the used glove tucked inside your gloved hand
4. Pinch the cuff of the gloved hand open slightly with your bare thumb and index finger, reaching underneath

Figure 4.4 **Donning of Sterilized gloves (Closed Method)[12, 14]**



5. Take off the second glove by turning it inside out as you slide it over the first glove, which you already took off

6. Dispose off the used gloves in biomedical waste collection bin as per existing government regulations

7. Perform hand hygiene

Aprons and Gowns

Doctors and nurses have a variety of protective clothing to choose from, depending on the situation. Here's a breakdown:

Aprons: These offer basic protection for your front and are used for tasks with minimal mess.

Surgical gowns: These longer gowns provide more extensive coverage for high-risk procedures like surgery.

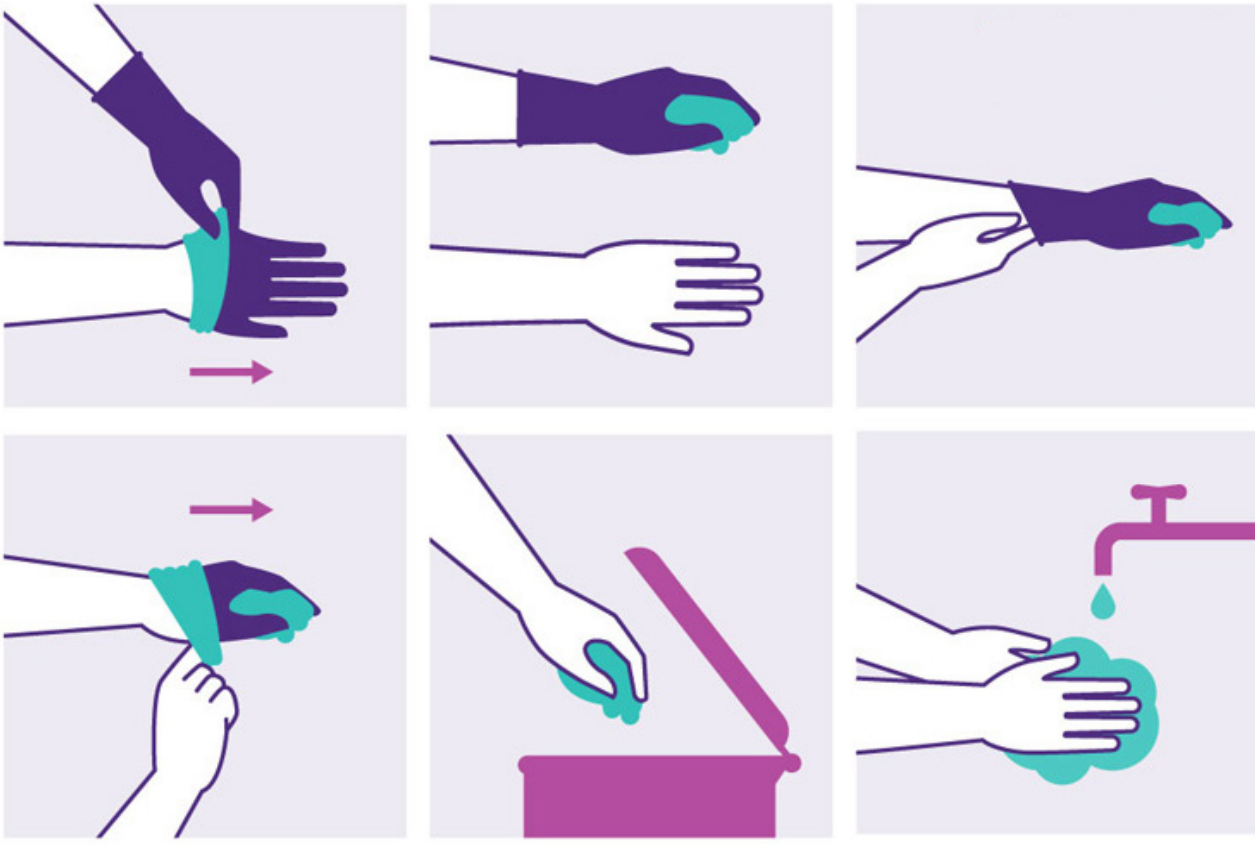
Isolation gowns: Similar to surgical gowns, but for use in situations where contact with infectious diseases is a concern.

Coveralls: These one-piece suits offer full-body protection for hazardous environments.

In short, aprons are for quick jobs with low mess, while surgical and isolation gowns are for procedures with a higher risk of contamination.[16]

Gowns are second most commonly used PPE followed by gloves in healthcare facilities.[17]

Figure 4.5 **Doffing of gloves** [15] **(Image source: Countrywide Healthcare, UK)**



Aprons & Gowns: Features[3]

1. Plastic apron

- Impervious/fluid-resistant
- For single patient use only
- Disposable
- Suitable for low-risk situations where there's a possibility of clothing contact with blood or body fluids from the environment, but the risk of contamination to the wearer's arms is minimal
- Necessary when there's a good possibility of touching the patient or their surroundings

2. Gown

- For single patient use only
- Disposable
- Worn to protect skin and prevent soiling of clothing during procedures and patient-care activities that are likely to generate splashing or sprays of blood or body substances
- Choice of sleeve length depends on the procedure being undertaken and the extent of risk of exposure of the HCWs arms

3. Full body gown

- Fluid-resistant
- For single patient use only
- Long-sleeved
- Worn when there is direct contact with a patient's broken skin (cuts, wounds, abrasions)
- Worn when there is prolonged skin-to-skin contact with a patient (e.g., lifting someone with scabies or compromised skin)
- Worn when there is exposure to blood and bodily fluids (e.g., uncontrolled vomiting, diarrhea)
- Necessary for procedures where there is risk of exposure to a large amount of blood or bodily fluids is expected

4. Sterile gown

- Pre-packed
- Essential for procedures demanding a sterile environment

5. Linen gowns

Reusable gowns can be laundered and sterilized as required before reuse. The World Health Organization (WHO) recommends reserving reusable gowns for situations where supplies are scarce and disposable options aren't available. However, these reusable gowns must be properly cleaned and processed between uses.

Table 4.2: Indications for gowns and aprons[18]

 When to wear disposable plastic aprons	• Contact with patients in isolation side rooms or cohort bays (yellow, white or clear apron) • Venipuncture or cannulation • Assisting with washing or bathing; changing dressings; assisting patients with using commodes or bed pans; cleaning commodes • Emptying catheter drainage bags • Cleaning or decontaminating equipment • Changing soiled or contaminated linen • Cleaning bathrooms or toilets, or general ward areas • While working in ward kitchens or serving patient food
 When to wear full-length fluid-repellent gowns	Any situation or intervention where there is a risk of extensive contamination of the arms and uniform from blood and/or body fluids, such as surgery or invasive procedures, and childbirth.
 Disposable plastic aprons are not required for	Routine contact with patients, such as when taking vital signs, assisting with mobility or giving oral medication or injections.

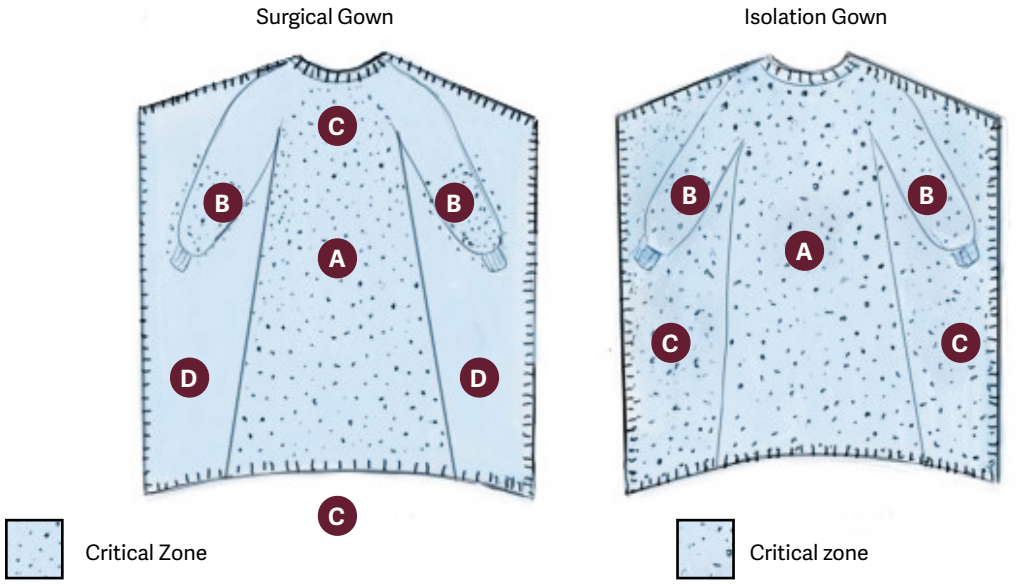
When gowns should be removed or changed [19, 20, 21]

- To prevent contamination, plastic aprons and fluid-repellent gowns should only be worn once. Discard them after each use on a patient
- Gowns can trap germs, so for quick cleaning, use an alcohol-based hand rub (ABHR) while wearing one. Remember, soap and water handwashing is ideal when you're not wearing a gown

Critical areas of surgical gown and isolation gown

The parts of gown most likely to get contaminated are called critical zones. These parts of surgical gown are enforced with extra protection while other area is made of normal material[22]

Figure 4.6 **Critical areas of Surgical and Isolation Gown** (Image source: Centers for Disease Control and Prevention (CDC))



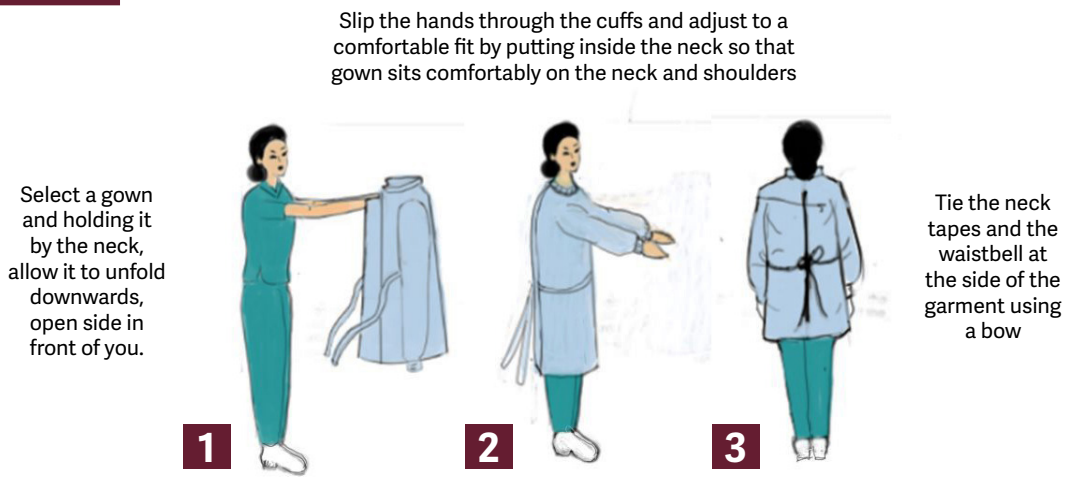
In Surgical Gown the critical zone compromises at least areas A and B.The back of the surgical gown (area D) may be nonprotective. In isolation gown the entire gown (areas A, B, and C), including seams but excluding cuff, hems, and bindings, are required to have a barrier performance

Donning of the gown[8, 26, 27, 29]

- As demonstrated in step 1 select a gown and hold it by the neck, allow it to unfold downwards, with the open side infront of you (This gown offers head-to-toe protection. It reaches the neck at the top, covers the legs down to the knees, and has sleeves that extend to the wrists Additionally, it wraps comfortably around the back)
- As demonstrated in step 2 slip the hands through the cuffs and adjust to a comfortable fit by pulling inside the neck so that the gown sits comfortably on the neck

* For gowns with back closures, ensure a helper secures the back ties while you focus on maintaining a sterile field. Remember, your sterile gloves should always extend over the gown's cuffs to create a complete barrier.

Figure 4.7 **Donning of the Gown** (Image source: Inspired by WHO guidelines)



and shoulders

- Fasten the neck opening by tying the strings behind your head. Tie the gown securely at the waist, ensuring the back panels overlap completely for maximum coverage of your clothes

Doffing of the Gown[8]

- Untie the waistbelt
- Untie the neckties and undo the closure
- With a peeling motion, starting from the shoulders, pull the gown down your arms, turning it inside out as you go
- Minimize touching the gown itself: roll it up inside out to form a ball
- Handling by the inside surface only and holding away from the body, discard the gown into a waste bin

Take off and dispose off your apron or gown properly before leaving the patient's environment.

Figure 4.8 **Doffing of the gown** (Image source: Inspired by WHO guidelines)

1. Untie the waistbelt

2. Untie the neckties and undo the closure.

3. Remove first one then the other sleeve and slip the gown off.

4. Handling by the inside surface only and holding away from the body, discard the gown into a waste bin.

5. Decontaminate the hands.

- Decontaminate the hands

Facial Protection (eyes, nose, and mouth)

To shield your eyes, nose, and mouth from germs, consider the risk of splashes or sprays before each task. If needed, wear the appropriate facial protection gear.[28-31] Face-masks, face-shields and eye goggles are the most important equipment for facial protection.

Face-masks

For optimal protection, a mask should create a complete seal around your nose and mouth, blocking any splashes or fluids.[24-29]

Indications:

- If there's a chance of blood splatter getting into your mouth or nose, wear a face shield along with a mask for extra protection
- During aerosol generating procedures
- During surgical procedures

When should a surgical mask be removed/changed [23, 24, 32]?

- After completing the procedure/task on the patient
- Masks can lose their effectiveness over time. Replace yours if it becomes damp from use or contaminated with a patient's fluids
- As per manufacturer instructions

Table 4.3: Types of facemasks used in healthcare facilities:

Types of Masks	
Masks are of different types. The best mask choice depends on your job duties and the potential risks you face. Here in the hospital/community setting (depending on where you work), there are two main types of masks recommended for different healthcare workers.[24, 26, 27]	
 Medical/Surgical masks (Triple layer masks)	• Disposable masks are fluid-resistant and offer some protection from splashes or sprays of droplets from coughs, sneezes, or talking of an infected person • These masks don't have filters, so they won't protect you from inhaling tiny particles • These are meant for single use and should be thrown away after they get dirty or wet, or after each use[25]
 FFP2/N95 or KN95 masks	• They provide the high level of protection from particles, including viruses[22, 26, 27] • These masks have filtering efficiency of around 95%[22, 26, 27] • These masks have markings printed on the product to indicate they are authentic[28] • The mask forms a sieve • High fluid resistance: They effectively block splashes and sprays • Good breathability: They allow for comfortable airflow during wear • Easy to identify inside and out: Clear distinction between the inner and outer surfaces helps with proper wear • Unique shape that stays put: The duckbill or cup-like design keeps the mask from collapsing against your mouth, ensuring a better fit and reducing fogging on glasses[28]

Figure 4.9 **Types of masks**

Surgical mask FFP2/N-95 mask

Donning and doffing of surgical masks[8, 21, 28]

Table 4.4: Technique for Donning and Doffing of surgical face masks

Donning of mask

- Clean hands first: Wash your hands with soap and water or use an alcohol-based hand rub before touching the mask
- Inspect your mask: Give the mask a quick check for any tears or holes. Don't use a damaged mask!

Ties or loops?

- Ties: If your mask has ties, bring the top ones to the crown of your head and tie a secure bow. Repeat with the bottom ties at the nape of your neck
- Ear loops: Hold the mask by the loops with the colored side facing outwards. Place the loops over your ears and gently mold the flexible nose piece to fit the shape of your bridge of nose for a snug fit
- Fit matters: Make sure the mask covers your nose, mouth, and chin completely. There shouldn't be any gaps between the mask and your face
- Avoid touching the front: Once your mask is on, avoid touching the front of it. If you do accidentally touch it, wash your hands again
- Remember: A well-fitting mask is key for optimal protection

Doffing of mask

- Don't touch the front! Resist the urge to grab the front of the mask
- Untie the ties: If your mask has ties, untie the bottom ones first, then the top ones. Be careful not to touch the mask itself while doing this
- Slip off the loops: For masks with ear loops, tilt your head forward slightly and gently slip the loops off one ear at a time
- Discard immediately: Once the mask is off, throw it away in a lined biomedical waste bin
- Clean hands again: Wash your hands with soap and water or use an alcohol-based hand rub to avoid transferring any germs

Donning and Doffing of N95 Masks[1, 26, 27, 29]

Table 4.5: Technique for Donning and doffing of N95 masks.

- Clean hands first: Wash your hands thoroughly with soap and water or use an alcohol-based hand rub before touching the respirator
- Inspect for damage: Give your respirator a quick check for any tears, cracks, or loose parts. Damaged respirators won't protect you – replace it if needed!
- Get it ready: Hold the respirator in your hands with the nose piece at your fingertips
- Position under your chin: Cup the respirator in your hands, letting the headbands hang below. Place it under your chin with the nose piece facing upwards
- Secure the straps: The top strap goes over your head and rests at the crown. The bottom strap goes around your neck and below your ears. Don't crisscross the straps!
- Mold the nose piece: Pinch the metal nose clip (if present) with your fingertips on both hands at the top. Slide your fingers down both sides of the strip to mold it to the shape of your nose for a snug fit
- Remember: A well-fitting respirator is crucial for optimal protection. If you have any difficulty breathing or feel air leaks, check the fit and consult a safety professional

User seal check

An N95 respirator is only effective if it fits snugly against your face. That's why a seal check is essential every time you put one on.
A seal check is a fast and simple way to make sure there are no leaks between the respirator and your skin.

Positive pressure user seal check

Exhale gently while blocking the paths for air to exit the face piece.

Exhale that the face piece is slightly pressurized before pressure causes outward leakage.

Negative pressure user seal check

Exhale gently while blocking the paths for air to exit the face piece.

Inhale that the face piece collapses slightly under negative pressure that is created with this procedure.

Doffing of N95 masks safely

- Don't touch the front! Remember, the front of the respirator is contaminated. Avoid touching it at all during removal
- Unstrap carefully: Start by pulling the bottom strap over the back of your head. Then, reach back and remove the top strap without touching the respirator itself
- Lift and discard: Once both straps are off, carefully lift the respirator away from your face and discard it immediately in a designated waste bin
- Clean hands again: Wash your hands thoroughly with soap and water or use an alcohol-based hand rub to eliminate any germs you might have transferred

Figure 4.10 **Donning of N95/Filtering face piece masks** (Image source: WHO)

Figure 4.11 **Doffing off a N95/Filtering face piece mask** (Image source: WHO)

Face shields

- Face shields are PPEs that protect the face and delicate areas like the eyes, nose, and mouth from splashes, sprays, and splatters of body fluids. This makes them valuable equipment for medical, dental, veterinary professionals, and others who might encounter such risks[30]
- Face shields offer protection from splashes and sprays, and they typically need backup from other gear like masks, goggles, and head covers for a complete defense. That's why they're called adjunctive PPE – they work best when used with other protective equipment[31]

Indications[1, 8, 30]

- Face shields are used during procedures that generate airborne particles such as intubation, bronchoscopy, or suctioning, as they may be at higher risk of exposure to infectious agents
- Face shields are used in combination with masks to provide an extra barrier against the transmission of infectious agents[32]

Table 4.6: Donning and Doffing of face shield

Donning

- Clean hands first: Wash your hands thoroughly with soap and water or use an alcohol-based hand rub to avoid contamination
- Inspect your shield: Give the face shield a quick check for cracks, scratches, or anything else that might affect its effectiveness
- Position yourself: Bend forward slightly for easier maneuvering
- Secure the shield: Hold the straps on either side of the face shield and gently stretch the elastic band with your thumbs. Place the band comfortably at the back of your head, ensuring the foam cushion rests comfortably on your forehead
- Check the fit: Make sure the shield covers your entire face from the forehead to below the chin, with no gaps on the sides. The forehead band should be positioned about an inch (3 cm) above your eyebrows
- Avoid touching the front: Remember, the front of the shield is considered contaminated, so avoid touching it while wearing it

Doffing

- Head tilt: Tilt your head forward slightly for easier removal
- Unstrap carefully: Grab one of the straps at the temple area and gently pull it forward and over your head
- Disposal: If the face shield is disposable, discard it in a designated waste bin
- Cleaning (reusable only): If the face shield is reusable, place it carefully in a designated storage container for cleaning and disinfection later
- Clean hands again: Wash your hands again with soap and water or use an alcohol-based hand rub to remove any germs you might have transferred

Full Face Shield Disinfection (After removal)[31, 33]

- Put on appropriate PPE
- Disinfection of the face shields depends on the material used
- Thick plastic ones may be disinfected by using freshly prepared 0.1-0.5% of Sodium Hypochlorite
- Face shields should be fully immersed in the solution and a contact period of at least 10 minutes should be strictly adhered to
- Rinse with tap water and dry

Other method

- For thin plastic face shields, alcohol wipes may be used
- Using a disinfectant wipe, thoroughly clean the patient-facing side of the shield
- Once the front is disinfected, turn the shield over to clean the inside
- Wipe down the entire inner surface of the shield, including the strap or ear loops (depending on the type) with the disinfectant wipe
- Let it air dry
- If face shield appears damaged or torn – discard

Safety goggles

Indications:[8, 33, 34, 35]

- Wear eye protection i.e. goggles whenever splashes or sprays of blood or body fluids are a risk. This includes procedures like surgeries of any kind, endoscopy procedures, bone drilling or surgeries involving blood vessels, laser surgery (to protect from laser beams and splashes) and other situations where splashes or sprays are a possibility
- Health care workers who perform laser procedures should wear safety goggles to protect their eyes from harmful laser beams
- During procedures that generate aerosols, such as suctioning or nebulizer treatments, safety goggles should be worn for safeguarding the eyes from exposure to infectious droplets
- Health care workers who handle hazardous chemicals, such as antineoplastic drugs, should wear safety goggles to protect their eyes from splashes and spills

Table 4.7: Donning and Doffing of safety goggles

Donning

- Perform hand Hygiene
- Take the safety goggles and ensure they are clean and free of any damage or defects
- Hold the goggles by the temples and place them over your eyes, ensuring that the lenses are centred over your eyes
- Adjust the straps or band to fit comfortably around your head, making sure that the goggles are snug against your face without causing pressure points or discomfort
- Check that the goggles are securely in place and that there are no gaps between the goggles and your face

Important points

- Protective goggles can be worn over vision glasses[44]
- While glasses help your vision, they don't provide the same level of safety as goggles in situations with a risk of splashes or sprays
- Goggles with antifog feature improves clarity of vision
- Do not touch the front of goggles

Doffing

- Use un-gloved hands
- Remove the safety goggles by lifting them away from the face. Avoid touching the inside of the goggles to reduce the risk of contamination
- Place the goggles in a designated area for cleaning or disposal, if necessary

Important point

- Eye protection must be discarded if damaged/rendered optically non-clear on repeated usage

Safety goggle disinfection[37]

- Donn suitable PPE
- Clean the goggles with soap/detergent and water and then immerse in 0.1-0.54% freshly prepared Sodium Hypochlorite for 10 minutes
- Wash/wipe the inside and outside of goggles with clean water to remove the residue
- Air dry completely on a clean flat surface or by hanging them in a clean place or use a clean tissue paper/dab to dry it
- Store it in a paper bag/in a clean area to avoid recontamination
- Remove gloves and perform hand hygiene

Important point

- Reprocessing must be done after every use before using it again

Headcover/Hair covers

Indications:[38]

- A head cover is a key part of surgical attire. It must be worn whenever you enter restricted or semi-restricted areas to prevent hair shedding and contamination
- Head cover should be worn in procedures where splashing/spraying of blood/body fluids is anticipated
- Wearing a head cover can help contain shedding hair, reducing the potential for hair and skin particles to become airborne and spread infections
- Head covers can help in preventing contamination of the equipment, such as surgical instruments, by keeping hair and scalp oils away from them

Table 4.8: Donning and doffing of head cover

Donning a head cover

- Perform hand hygiene with soap and water/ ABHR (Alcohol- based Hand Rub)
- Take the head cover and unfold it
- Position the head cover so that the elastic band is around your neck and the top of the head cover is at the top of your forehead
- Pull the head cover up over your head and adjust it to cover your hair and neck

Important points

- Long hair must be secured and hair cover to be used to protect the patient from falling hair
- When wearing a gown for patient care, a head cover is essential. It should fully enclose your head and neck to minimize hair shedding and prevent contamination[34]

Doffing a head cover

- Perform hand hygiene
- Remove any gloves or other PPE you may be wearing
- Gently reach up and grab the bottom edge of the head cover. Pull it downwards and away from your face in a smooth motion
- Hold the head cover away from your body and place it in a designated biomedical waste collection bin for disposal
- Perform hand hygiene again

When should headwear be removed or changed?

- Before leaving the patient care area
- After completion of procedure
- At the end of operation theatre working session
- In case of visible soiling/contaminations
- As per the manufacturer's instructions

Shoe covers

Floors may become a breeding ground for organisms. The coverings keep shoes clean and prevent the transmission of infection from one place to another.[39-41]

It is not recommended to wear outdoor shoes in sterile environments or operating rooms. Hence, it is imperative that either separate shoe are worn before entering Operating room or shoe covers are worn as they prevent contaminants from entering the room.

Indications:[38, 41]

- In situations where patients' bodily fluids might splash, spill, or leak, wear closed-toe shoes that can be easily decontaminated to prevent contamination spread
- Wear shoe covers to provide a barrier against possible exposure to airborne organisms or contact with a contaminated environment
- Use shoe covers for patients with haemorrhagic disease
- Shoe covers are a vital part of Full Barrier Precautions

Table 4.9: Types of shoe covers [19, 42]

Disposable shoe covers		• Disposable fluid resistant or impermeable • Shoe covers should be designed to allow for free movement and a good grip to prevent slips or falls • They should provide protection without compromising your mobility[56]

Table 4.10: Donning and Doffing of shoe covers

Donning of Shoe Covers[42]

- Step into the shoe cover with one foot, pulling it up over the foot and ankle. Repeat this process with the other foot
- Make sure the shoe covers are properly positioned and secure on your feet. If the covers have elastic bands, adjust them around your ankles to ensure a snug fit
- Make sure the shoe covers are comfortably covering your entire foot and ankle, without slipping off or bunching up
- Try not to touch the floor or other areas with your hands while putting the shoe covers on. If you do, disinfect your hands before putting your inner gloves on

Important points:

- Make sure your feet are clean and free of any contaminants that could transfer to the shoe covers
- For safety one can sit in the chair and start with the process

Doffing of Shoe covers

- Lift one foot up and slide fingers of ungloved hand into inside portion of the impermeable shoe cover
- To remove, pull elasticized cuff down and away from ankle area and peel the impermeable shoe cover off of foot
- Step with that foot only over the threshold of the door and set that foot down on the floor outside of room
- Dispose off the shoe covers in appropriate waste collection bin
- Repeat the process with the second shoe cover
- Carry out hand hygiene

Rationale for use of personal protective equipment during severe shortages[20, 21]

Public health emergencies create a global surge in demand for Personal Protective Equipment (PPE). To make the most of limited supplies, healthcare providers need to optimize their use. Organizations like the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) have prescribed guidelines which covers three key areas:

1. **Maintaining Supply:** How manufacturers can effectively track and manage their PPE production to meet increased demand
2. **Rationing Supplies:** Strategies for healthcare facilities to allocate PPE efficiently based on risk and necessity
3. **Optimizing Use:** Best practices for healthcare workers to extend the lifespan and effectiveness of their PPE

By following these guidelines, we can ensure that essential protective gear reaches those who need it most during critical times.

Levels of Personal protective equipment[20, 43, 44]

Personal Protective Equipment (PPE) can be categorized into different levels or classes based on the degree of protection they provide and the specific hazards they are designed to mitigate. The exact categorization may vary depending on the context, industry, and regulations, but here are some common levels of PPE.

The categorization of Personal Protective Equipment (PPE) into different levels can also help in rationalizing the use of PPE. Figure 4.11 shows one such categorization which was used during COVID -19 Pandemic.

Table 4.11: Levels of Personal Protective Equipment (PPE)[44]

Level	Level I	Level II	Level III
PPE Kit	General use kits (non-COVID areas)	Coverall - based PPE kits	Bio - safety coverall - based kits
Components	Coverall-based PPE kits Surgical gown + N-95 mask + goggles + gloves	Coverall + hood + N-95 mask + goggles + long shoe covers + gloves	Bio - safety coverall + N-95 mask + goggles + long shoe covers + gloves
Type of patient care area	Non-COVID areas	COVID wards	COVID ICU & HDU

HDU: high - dependency unit ICU: intensive care unit

It is essential to follow the Hospital's PPE guidelines and select the prescribed level of PPE based on the risk of exposure to infectious agents to protect healthcare workers and patients.

Sequence of Donning and Doffing of PPE [8, 45]

1. Donning and doffing are terms used to describe the processes of putting on and taking off PPE. These processes are critical to minimizing the risk of infection transmission, especially in healthcare settings where healthcare workers are exposed to infectious agents

Donning of PPE

Before donning[8]

1. Get into scrubs or comfortable clothes, remove jewellery, ensure you have water and food and visit washrooms etc. as the doctors and nurses are expected to stay inside for at least 6 hours

2. Don your PPE with a colleague who can assist and provide a final check

3. Check all PPE before starting donning

Area for Donning[5]

- Designate a separate, well-lit area with controlled access
- Keep the area clean with clear signage and hand hygiene stations
- Stock necessary supplies and equipment to ensure smooth donning

PPE Donning procedure with N95 Respirator Option (Reproduced from CDC, USA) [36]

1. Trained observer to visually confirm the successful PPE donning and check for any exposed clothing, skin, or hair
2. Remove personal clothing and items: Change into surgical scrubs, dedicated washable footwear, and tie long hair
3. Inspect PPE before donning: Check the PPE ensemble for serviceability, availability of required items, and correct sizes. Review the donning sequence before starting
4. Put on footcovers: If wearing a coverall without integrated socks, wear foot covers with the upper band under the coverall pants leg
5. Put on inner gloves: Put on the first pair of gloves
6. Put on gown or coverall: Put on a gown or coverall. Ensure the cuffs of inner gloves are tucked under the sleeve
7. Put on N95 respirator: and perform a user seal check
8. Put on surgical hood: Place a surgical hood over the N95 respirator, covering all hair, ears, and extending to the shoulders. Ensure it completely covers the ears and neck
9. Put on Outer Apron (if used): Add a disposable apron for additional front body protection
10. Put on Outer Gloves: Put on a second pair of gloves with extended cuffs. Ensure the cuffs are pulled over the sleeves of the gown or coverall
11. Put on face shield: Wear a full face shield over the N95 respirator and surgical hood for eye and face protection

Note: The HCW should have unrestricted movement while remaining correctly covered. A mirror can be used during donning.

Doffing PPE, N95 Respirator Option

Follow these concise steps for safe and effective PPE removal:

1. Engage a Trained Observer: A trained observer should supervise the doffing process and confirm each step visually
2. Inspect PPE: Check for visible contamination, cuts, or tears before starting the removal process
3. Disinfect Outer Gloves: Clean outer-gloved hands using an approved disinfectant wipe or ABHR
4. Remove Apron: Break or untie the neck strap and release waist ties to remove the apron, ensuring the soiled outer surface is contained
5. Inspect PPE Ensemble: After removing the apron, check for visible contamination, cuts, or tears. Clean and disinfect any affected areas using approved disinfectant wipes
6. Disinfect and Remove Outer Gloves: Disinfect outer-gloved hands and carefully discard the outer gloves, without contaminating inner gloves
7. Inspect and disinfect Inner Gloves: Check inner gloves for visible contamination, cuts, or tears. Disinfect them if necessary, or remove, perform hand hygiene, and replace with a new pair of gloves
8. Remove Face Shield: Tilt your head forward and gently remove the full-face shield, avoiding touching the front surface
9. Disinfect Inner gloves: Clean the inner side of the gloves using an approved disinfectant wipe or ABHR
10. Remove surgical hood: Unfasten and remove the surgical hood, with the assistance of a doffing assistant if required
11. Remove Gown or Coverall: Remove and discard the gown or coverall, ensuring that the scrubs or disposable garments do not touch the outer surface
12. Remove Boot Covers: Sitting on a clean surface, remove the boot covers without contaminating the scrubs pants legs
13. Disinfect and Change Inner Gloves: Clean the inner-gloved hands and replace with a new pair of gloves
14. Remove N95 Respirator: Remove the N95 respirator by grasping the bottom and top ties or elastic straps without touching the front. Discard the respirator
15. Disinfect Washable Shoes: Wipe down all external surfaces of the washable shoes with approved disinfectant wipe
16. Disinfect and Remove Inner Gloves: Clean the inner-gloved hands and discard the gloves without contaminating the bare hands.

Table 4.12: Ways to address PPE fatigue

Training and education	Healthcare workers should receive proper training and education on the correct use of PPE.
PPE selection and fit	Healthcare facilities should provide PPE that is comfortable, properly fitted, and appropriate for the task at hand.
Breaks and rest periods	Healthcare workers should take regular breaks and rest periods to alleviate physical and psychological fatigue associated with wearing PPE.
Mental health support	Healthcare workers should have access to mental health support services, such as counselling and peer support, to help cope with the stress and anxiety associated with wearing PPE.
Team support and communication	Healthcare workers should have clear communication and support from their team and supervisors to ensure that they feel supported and encouraged.

17. Perform Hand Hygiene: Perform hand hygiene using ABHR
18. Final Inspection: Before leaving the patient's room, both the healthcare worker and a trained observer should inspect the surgical scrubs or disposable garments for any visible contamination. If even a small spot of blood, body fluids, or other contaminants is found, the garments must be removed immediately. The healthcare worker should then shower as soon as possible to minimize the risk of spreading infection
19. Scrubs and Evaluation: Put on clean, dedicated scrubs (washable) or disposable garments along with footwear specifically designated for use in showering areas. This helps maintain hygiene and prevents contamination from spreading to other areas. Regularly meet with an infection preventionist or occupational health coordinator for protocol evaluation and medical assessment

By following these guidelines, you can ensure safe doffing of PPE and maintain a high level of infection prevention.

PPE Fatigue[46, 47]

- PPE fatigue refers to the physical and psychological exhaustion experienced by healthcare workers who wear the PPE for extended periods of time
- Healthcare workers are required to wear PPE for long hours to prevent the transmission of infectious agents and protect themselves and others from exposure
- However, the prolonged use of PPE can cause physical discomfort, such as pressure sores, skin irritation, and difficulty in breathing. It can also cause psychological stress and fatigue, including anxiety, frustration, and a sense of isolation

In summary, PPE fatigue can be a significant issue for healthcare workers, and it is important to address it to maintain the safety and well-being of healthcare workers and patients. Healthcare facilities should implement strategies to alleviate physical and psychological fatigue associated with wearing PPE, including training and education, appropriate PPE selection and fit, breaks and rest periods, mental health support, and team support and communication.

Evidence from systematic review

The effective use of Personal Protective Equipment (PPE) is crucial in managing COVID-19 patients, especially in high-risk settings such as the Intensive Care Units (ICUs) and during aerosol-generating procedures.[48, 49] While there's an emphasis on placing critically ill patients in isolated rooms, the importance of comprehensive PPE measures for healthcare professionals, including goggles, cannot be understated due to the detectability of SARS-CoV-2 in body fluids.[50] Correct theatre ventilation is vital, especially when operating on COVID-19 patients.[2]

Training in PPE usage is of paramount importance. Emergency training has shown significant improvements in healthcare workers' abilities to utilize PPE effectively.[1] Innovative training methods, like the DOFFICERS' Rapid Response Program and Simulation-Based Mastery Learning, have proven beneficial in increasing the confidence and competence of healthcare workers.[51, 52]

Innovative solutions, such as the utilization of Clyraguard, a copper iodine complex, could reduce cross-contamination of non-critical PPE.[53] Masks, especially N95 respirators, have been recognized to offer stronger protection against respiratory infections in health care settings.[1] The comparative effectiveness between N95 respirators and medical masks remains a topic of discussion, emphasizing the need for more randomized trials.[53] Cloth and 3D-printed masks might benefit from nanofibers for improved filtration.[54]

Alternative doffing strategies, like the One Step (OS) doffing method, have been proposed to address challenges in PPE usage.[55] An essential aspect of these protective measures is the design of PPE donning and doffing areas, with recommendations including a 16 m^2 dedicated room.[53, 55] Strategies from China, including level-3 protection protocols, have shown efficacy.[52] The introduction of a care escalation framework ensures workplace safety by reporting PPE-related lapses.[56]

Practical challenges such as fogging in goggles have been addressed with solutions like mask adjustments and specialized antifogging solutions.[57] Physical barriers, such as acrylic windows in initial patient contact areas, can help conserve PPE supplies.[58] Moreover, the potential for PPE reprocessing, with methods like UVGI, microwave-generated steam, and hydrogen peroxide vapor, is being explored.[52]

Despite global PPE recommendations, differences in actual use have been noted, and misuse, including overuse, can strain limited supplies.[59] Insights suggest the importance of PPE monitoring teams for correct PPE usage in COVID-19 care settings.[60] Lastly, the primary purpose of PPE is to redirect potentially virus-laden exhalation jets, with certain tools, like open face shields and mouth visors, showing superiority in minimizing short-distance airborne exposure.[56]

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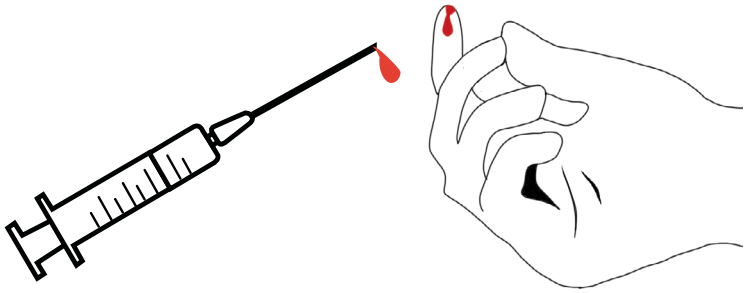
Chapter 5

Needle and Sharp Injury Prevention

Picture Credit: AIIMS, New Delhi

Needle and Sharp Injury Prevention



The initial documented instance of HIV transmission through a needlestick injury (NSI) as reported anonymously in 1984, triggered growing apprehension and awareness regarding the potential dangers faced by healthcare personnel due to injuries involving sharp objects.[1]

A study by WHO estimated that each year proportions of Health-Care Workers (HCW) exposed to blood-borne pathogens globally were 2.6% for HCV, 5.9% for HBV, and 0.5% for HIV, corresponding to about 16,000 HCV infections and 66,000 HBV infections in HCWs worldwide.[2] The incidence of NSIs varies based on the specialization, type of work, and the workplace setting.[3]

More than 20 blood-borne pathogens might be transmitted from contaminated needles or sharps. The three major infections that can result from a needlestick injury are HIV, Hepatitis B, and Hepatitis C. These three viruses can potentially be contracted by splashing blood on the mucosal surfaces of the body or by a percutaneous needlestick injury.[4]

Majority of healthcare personnel contracting a needle stick injury do not develop the infection. The type of exposure, the volume of blood and bodily fluids involved in the contact, and the viral load of the infection source all affect the risk of infection.

In hospitals and healthcare settings, various sharp instruments are used for medical, surgical, diagnostic, and therapeutic purposes. Below is the indicative list of some routinely used sharp instruments (sharps) in a healthcare setting.

- Scalpel
- Needles
- Syringes
- Lancets
- Surgical Scissors
- Trocars
- Biopsy Punches
- Retractors
- Cautery Devices
- Ophthalmic Knives and Blades
- Dermal Curettes
- Trocar Cannula
- Ostomy Supplies
- Acupuncture Needles
- Surgical Staples
- Disposable Razors
- Skin Biopsy Instruments
- Intravenous (IV) Catheters
- Vascular Access Needles
- Epidural Needles

Table 5.1: Definitions of terms

Needle stick injury[5]	The term 'Needle Stick Injury' is a broad term that includes injuries caused by needles or other sharp objects (e.g., glass vials, surgical blades, forceps) that accidentally puncture the skin.
Sharps[5]	Anything that has the ability to cut the skin is a "sharp" object. Needles, scissors, razor blades, metal wire, retractors, scalpels, lancets, clamps, pins, staples, cutters, and glass items can be considered as sharps.
Occupational exposure	Exposure to potential blood-borne infections (HIV, HBV and HCV) that occur while providing health care services.
Exposed Person	A person who is potentially exposed during the course of work to an increased risk of contracting an infection due to contact with blood or other infectious bodily fluids.
Source	Source of infection, is any living thing, non-living material, or location where an infectious agent resides and replicates, potentially leading to its transmission to a susceptible host.

Table 5.2: What is infectious and what is not?[6]

Potentially infectious body fluids	
Exposure to body fluids considered 'at risk'	**Exposure to body fluids considered 'not at risk'**
Blood	Tears
Semen	Sweat
Vaginal secretions	Urine and Feces
Cerebrospinal fluid	Saliva
Synovial, pleural, peritoneal, pericardial fluid	
Amniotic fluid	
Other body fluids contaminated with visible blood	

All Healthcare workers are at risk of acquiring infections such as: healthcare facility cleaning staff, mortuary staff and hospital waste handlers, Laboratory technicians, Dentists, Emergency care providers, etc.

Average Risk of Acquiring HIV, Hepatitis B, and Hepatitis C after Occupational Exposure[7, 8]

The average risk of acquiring HIV infection following different types of occupational exposure is low compared to the risk of acquiring infection with HBV or HCV

- 0.3% for HIV
- 2.7–10% for HCV
- 6–30% for HBV [depends on the Hepatitis B envelope antigen (HBeAg) status]

Preventing Needlestick/Sharp Injuries

- Always dispose off needles and sharps in designated sharps containers. Never reuse them, as this dramatically increases the risk of injury
- Whenever possible, utilize safety devices like retractable needles or syringes with safety caps to minimize the chance of accidental needlesticks
- Healthcare workers must receive comprehensive training on the safe handling, disposal, and best practices for needles and sharps
- Wear nitrile or latex gloves whenever handling needles or other sharp objects for additional protection
- Avoid recapping needles whenever possible. If recapping is absolutely necessary,

employ a one-handed scoop technique or a designated mechanical device for safer handling

- Use designated sharps containers for disposing off used needles and other sharp objects. Never place them in regular waste bins
- Avoid rapid or careless movements when handling needles
- Familiarize yourself with your workplace's post-exposure protocol, including immediate actions to be taken in case of an injury
- Ensure that all healthcare workers are up-to-date on vaccinations for diseases like Hepatitis B to reduce the risk of infection following accidental exposure
- Record all incidents of needle stick injury as it is mandatory
- Sharps should never be passed directly from one person to another

Needlestick Injury Management[9]

Step 1: Immediate measures

Skin: If the skin is punctured by a needle or cut by a sharp instrument:

- Immediately wash the wound and surrounding skin gently with soap and water, then rinse thoroughly
- Do not squeeze the wound
- Do not scrub vigorously
- Do not put the injured finger or any wound in your mouth
- Avoid the use of antiseptics or harsh skin washes (e.g., bleach, chlorine, alcohol, betadine) unless specifically directed by a healthcare professional

Eyes and Mouth:

- Rinse your eyes with clean water, saline, or sterile wash immediately for several minutes. Do not use soap
- Spit out any blood or bodily fluids that enter your mouth, then rinse it with water multiple times

Report and Seek Medical Advice:

- Always report the injury or exposure to your supervisor or the designated person in charge as soon as possible. Seek medical advice promptly
- Depending on the circumstances, post-exposure prophylaxis (PEP) might be recommended to reduce the risk of HIV transmission. Early intervention is crucial

Step 2: Establish Eligibility for PEP

A HIV/HBV risk assessment must be conducted by a designated person or trained doctor following an Accidental Exposure to Blood (AEB). A detailed evaluation has to be done immediately following the incident to begin treatment at the earliest. Since prophylactic treatment is not necessary for every AEB, the decision is made based on thorough assessment.

It is ideal to administer the first dose of PEP within two hours (though preferably within 72 hours) of exposure to assess the risk right away. A PEP can be discontinued if the risk is considered insignificant. In order to be effective, PEP needs to be started within 72 hours of exposure.

Assessing the severity of exposure and risk of transmission
The amount of blood or body fluid involved and the entry port used can be used to categorize and describe the occupational exposure of a healthcare professional. (See Table 5.3)

Assessing the HIV Status of the Source of Exposure

When feasible, a baseline rapid HIV test of the source of exposure should be conducted before starting PEP. According to national HIV testing guidelines, informed consent must be obtained prior to testing of the source. When it is indicated, PEP should not be delayed while awaiting the results of the source of the exposure's HIV test. PEP needs to be started within 72 hours of exposure.

Table 5.3: Severity of exposure[8]

Category of Exposure	Definition and Example
Mild	Exposure of mucous membranes (eyes, nose, mouth) or non-intact skin to small volumes of fluids, or subcutaneous injections with small-bore needles.
Moderate	Contact with large volumes of body fluids at mucous membranes (ocular, nasal, or oral) and percutaneous injuries caused by solid needles, such as those sustained during needlestick injuries penetrating personal protective equipment (PPE) like gloves.
Severe	Large volume percutaneous exposure: • Deep puncture wounds with significant hemorrhage or pronounced pain • Accidents involving needles exceeding 18 gauge in diameter • Accidents involving needles visibly soiled with blood • Accidents involving needles with a history of intra-venous or intra-arterial use
Note: Wearing gloves is an accepted standard precaution across the globe. However glove punctures do occur. If the AEB involves materials like discarded sharps or needles or dried contaminated blood, the risk of HIV transmission persists for one week; the risk is greater for HBV and HCV because they survive longer outside the body than HIV.	

Table 5.4: Risk of transmission

Source HIV Status	Definition of Risk in Source
HIV negative	Source is not HIV infected; so consider HBV and HCV
Low risk	HIV positive and clinically asymptomatic.
High risk	HIV positive and clinically symptomatic

Assessment of the Exposed Individual

- An experienced physician should provide confidential counselling and conduct the assessment of the exposed individual
- It is necessary to assess and test the exposed individual for pre-existing HIV infection. This is meant to establish the HIV negative status of those who do not have HIV at the time of possible HIV exposure
- People who have been exposed and are later found to be HIV positive shouldn't be given PEP. It is important to offer counselling and information regarding HIV prevention and to refer them for clinical and laboratory tests for subsequent HIV testing. Furthermore, counselling (see Step 3) of exposed Healthcare Personnel is vital to allay fear and initiate PEP (as necessary)

Step 3: Counselling for PEP

- PEP risks and benefits should be adequately informed to the exposed person
- It should be made clear that PEP is not mandatory
- The client (exposed individual should be explained about the window period, baseline tests, and any risks relating to the identified PEP drugs in pregnancy and breastfeeding during the consultation
- Until both baseline and 3 months HIV tests are negative, he/she must be counselled about safe sexual practices
- Psychological support: Following exposure, many people feel anxious. The risks and measures should be explained to every person who is exposed. In some cases, further psychological support may be necessary, for reducing anxiety
- Maintenance of documentation is essential

Step 4: Assessing need for prescribing PEP

- PEP should be initiated at the earliest, ideally within 2 hours and preferably within 72 hours of exposure
- PEP can still be used after proper counseling about its efficacy if a healthcare personnel presents after 72 hours of exposure
- PEP should be made available in the Emergency Department, Labour Room, Intensive Care Units and Operation Theatres (OTs)
- The exposed individual should consult the designated physician or medical officer as soon as possible for comprehensive risk assessment, HIV counseling, testing and PEP
- All hospital staff members must know whom to report to for PEP and where PEP drugs are available
- All clients started on PEP must take 4 weeks (28 days) of medication. once the decision to give PEP is made, in all cases, the first dose of PEP should be offered as soon as possible
- In the case of a HIV-positive source, follow the NACO guidelines

Step 5: Laboratory Evaluation

- HIV testing is done soon after an occupational exposure in order to establish a "baseline" against which the future test results can be compared
- Pre-test counselling of exposed person before HIV testing should be done according to NACO guidelines
- Confidentiality of the test results must be ensured
- With informed consent, pre and post-test counseling and ensuring confidentiality, the HIV test can be conducted up to several days after the exposure
- HIV RNA testing by Polymerase Chain Reaction (PCR) during PEP has a very poor positive predictive value and should be strongly discouraged
- When available pregnancy testing should be offered; however, the provision of PEP shouldn't be affected if it is unavailable
- Depending on the type of risk, the source patient's symptoms, the prevalence in the area, and the capabilities of the laboratory, testing for additional blood-borne illnesses like syphilis, malaria, and kala azar can be beneficial
- Further laboratory testing, such as hemoglobin estimation, should be available, particularly in regions where anemia is prevalent and when Zidovudine is used for PEP

Step 6: Follow-up of an Exposed Person

- It is recommended to follow up to monitor for potential infections and to offer psychological support, regardless of whether PEP has been initiated
- For the continued care of the patient follow NACO guidelines for Clinical and Laboratory review

Incident reporting forms and audits

- Audit and incident reporting forms play an important role in ensuring the safety of both patients and healthcare workers in medical settings, especially when it comes to addressing the often underreported issue

Table 5.5: Recommended baseline laboratory Investigation

Timeline	In patients taking PEP (standard regimen)	In patients not taking PEP
Baseline	HIV, HCV, anti-HBs Ag*, complete blood count, serum transaminases	HIV, HCV, anti-HBs Ag*
It is recommended that exposed healthcare personnel should be tested for HIV, HBV, and HCV within six days of an AEB for the baseline sero status. In the event of an AEB, provide the patient with an HIV test; a positive result may suggest that PEP needs to be discontinued. The exposed person's informed consent should be the basis for deciding whether or not to test for HIV. Those who have been exposed but are not taking PEP should be advised to get tested again for HIV, HCV, and anti-HBsAg at 6,12 and 24 weeks from the initial exposure date.		

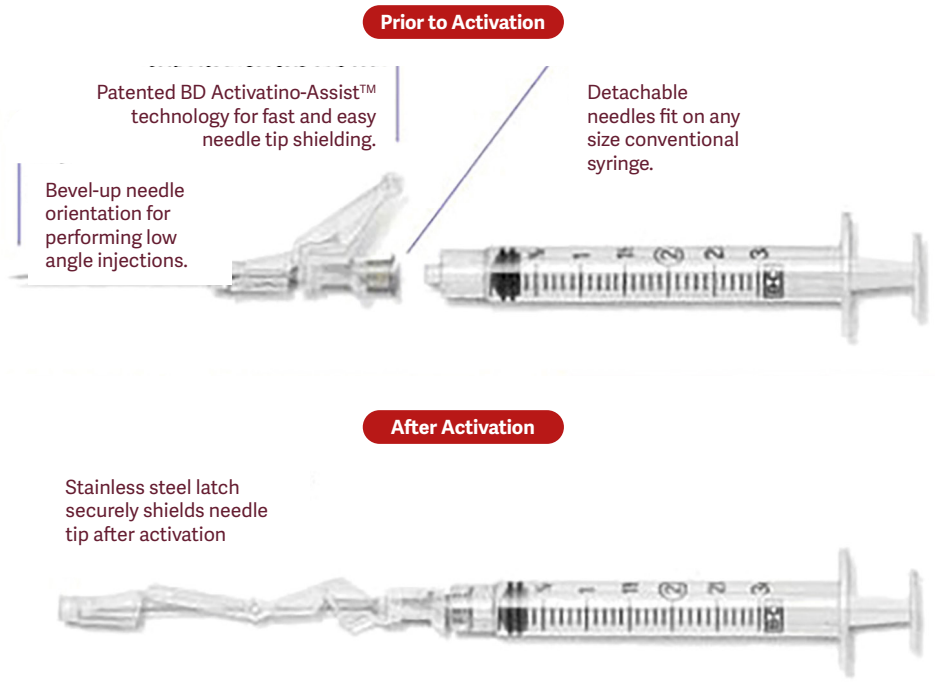
of needle stick injuries. These injuries, which involve accidental needle punctures, pose significant risks to healthcare providers. Thus, a strategic and detailed review of the incident reporting procedures can play a pivotal role in mitigating these incidents[10]

- Auditing Incident Reporting Forms: Auditing involves a detailed evaluation of the system responsible for logging and reporting needle stick injuries. Auditors examine the recorded incidents, their descriptions, the circumstances leading to them, and subsequent remedial actions, thereby identifying areas of improvement [11, 12]
- Importance of Auditing: Auditing forms an integral part of healthcare's quality assurance process. It identifies weaknesses in reporting systems, knowledge gaps, and non-compliance with safety protocols, thereby providing evidence-based data to support strategic decisions for reducing Needle Stick Injuries [13, 14]
- The Audit Process: The auditing process necessitates a deep understanding of the established policies, systems, and processes. Auditors then review the data focusing on incident details, reporting timelines, information accuracy, and the follow-up actions undertaken [12, 14]
- Compliance with safety protocols for needle handling and disposal forms crucial part of the audit. Non-compliance could indicate the need for more comprehensive training or stricter policy enforcement [15]
- Analysis of Findings and Recommendations: Post-audit, findings are analysed to identify trends, commonalities, and areas of concern. These findings can guide the formulation of realistic and achievable recommendations such as protocol modifications, advanced training programs, or implementation of safety-engineered devices [11, 16]
- Importance of Training and Education: Regular training sessions reinforce awareness of the risks associated with needle stick injuries and the correct procedures for handling and disposal of needles.[17] They emphasize the critical importance of reporting all needle stick injuries, regardless of their perceived severity[18]
- Use of Safety-Engineered Devices: Safety-engineered devices incorporate built-in safety features designed to prevent needle stick injuries. These devices, including self-sheathing needles, retractable needles, and shielded needle devices, have shown to significantly reduce the risk of accidental needle sticks when compared to traditional devices[19]
- Challenges in Safety-Engineered Device Adoption: Despite their documented benefits, safety-engineered devices are not universally adopted in healthcare settings. Factors such as cost, lack of awareness, resistance to change, and limited availability may hinder their widespread use.[20] Auditors can assess the current usage of these devices and provide recommendations for their adoption, addressing any implementation challenges that may arise [21]
- Regular Auditing: Conducting periodic audits ensures ongoing compliance with safety protocols and monitors the effectiveness of implemented changes. This continuous monitoring process allows for ongoing improvements, ultimately enhancing the effectiveness of strategies aimed at reducing Needle Stick Injuries

Periodic training

- A general training and educational program on universal precautions and proper use of sharp devices must be established in a hospital. This has to include not only the safe application of hollow-bore needles, but also their disposal, the adaptation of safe work practices and the reporting of Needle Stick Injuries
- Work-practice controls
- Steps that can be taken to reduce injuries include using instruments to grasp needles or load/unload scalpels, avoiding hand-to-hand passage of sharps, separating sharps from other wastes, not carrying garbage or linen bags close to the body, etc.

Figure 5.1 **Safety-Engineered needle to prevent 'NSIs'.** **(Image source: Ontario nurses association resources)**



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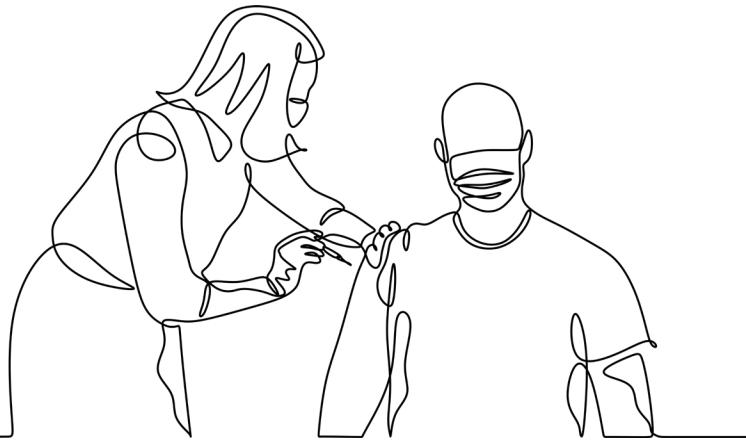
Chapter 6

Safe Injection Practices

Safe Injection Practices



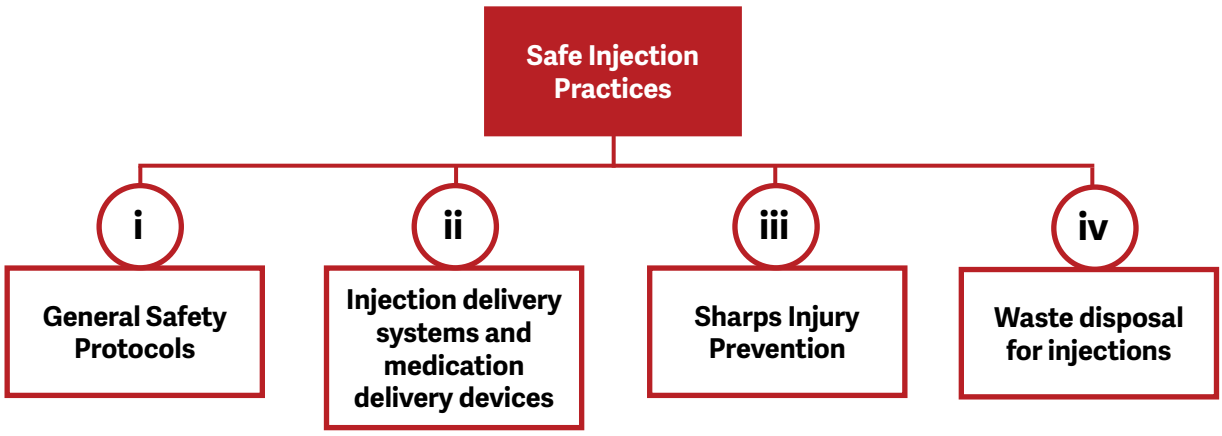
Safe Injection

A safely administered injection minimizes patient harm, protects healthcare workers from exposure, and prevents the spread of infections in the community. When injections are administered in an unsafe manner, it puts individuals at risk of dangerous and potentially deadly infections.[1]

Safe Injection practices

Safe injection practices encompass a set of guidelines and protocols implemented by healthcare professionals to prevent the transmission of infections during the administration of injections. These practices are of paramount importance in healthcare settings to ensure the well-being of both Healthcare providers and patients. Injection safety, or the adherence to safe injection practices, entails administering injections in a manner that avoids harm to the recipient, eliminates unnecessary risks for the Healthcare Provider, and avoids the generation of hazardous waste that could pose a danger to the community.

Figure 6.1 Safe Injection Practices



i. General Safety Protocols[2]

To prevent infections during injections and related procedures, healthcare providers should always follow these safety protocols:

Thorough hand hygiene (See Table 6.1)

Wearing gloves to create a barrier against germs using single-use personal protective equipment to minimize contamination risk.

Table 6.1: Practical guidance on hand hygiene during injection session

During injection session *Clean your hands thoroughly:* • Before starting an injection session (preparation and administration) • Before any direct patient contact for healthcare procedures • Before putting on gloves (dry hands are essential))	*Perform hand hygiene AFTER:* • An injection session • Any direct contact with patients. • Removing gloves
• Perform hand hygiene between injections • Avoid administering injections if the skin integrity is compromised by local infection or other skin conditions (e.g., weeping dermatitis, skin lesions or cuts), and cover any small cuts	

Ensuring skin disinfection for Injections[2]

Table 6.2 shows the skin preparation protocols for different types of injections.

Practical guidelines for skin preparation and disinfection[2]

To disinfect skin, follow the following steps:

- For disinfection, use a single-use swab or cotton ball moistened with a 60-70% alcohol-based solution (isopropyl or ethanol). Avoid methanol or methyl alcohol as they are harmful
- Starting from the center of the injection site, wipe the area outwards in a circular motion without revisiting the same spot
- Allow the alcohol solution to air dry completely for at least 30 seconds before proceeding

ii. Injection delivery systems and medication delivery devices[2]

Maintaining a sufficient inventory of single-use injection devices is a cornerstone of safe injection practices.

- **Availability and Accessibility:** Safe injection practices rely on a well-managed inventory of single-use injection devices in healthcare settings. This means establishing a minimum stock level based on historical usage and anticipated needs. A well-defined distribution system should be in place to ensure healthcare providers on every shift and in every department have easy access to the necessary syringes and needles. Regular inventory checks and reorder procedures are crucial to prevent stockouts. Implementing these measures safeguards both patients and healthcare

Table 6.2: Skin preparation for different types of injection[2]

Type of injection	Skin preparation and disinfection	
	Soap and water	60-70% of alcohol (Isopropyl alcohol and ethanol)
Intradermal	Yes	No
Subcutaneous	Yes	No
Intramuscular • Immunization • Therapeutic	Yes Yes	No Yes
Venous access	No	Yes

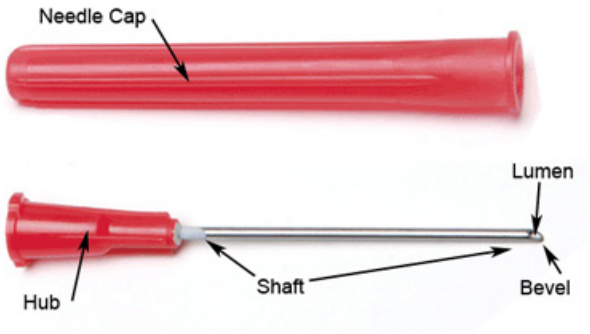
workers by preventing contamination during injections. Every procedure requires a new device to eliminate the risk of transferring bloodborne pathogens or other infectious agents

- **Components of a syringe:** A syringe consists of three main parts: the needle, the barrel, and the plunger
  - The needle is the part that goes into the patient's muscle or vein
  - The barrel holds the medication and is marked with measurements in millilitres (ml)
  - The plunger is used to draw medication into the syringe and to administer it

Table 6.3: Infection Prevention and Control Practices

For syringes and needles	
Do's	Don'ts
• Wash your hands thoroughly to prevent germs from spreading. Use soap and water or an alcohol-based hand rub. Make sure to scrub for at least 30 seconds, including your wrists and between your fingers. You can use the World Health Organization's "My 5 Moments for Hand Hygiene" as a guide for when to wash your hands • Change gloves between procedures and patients • For blood sampling and drawing, always use a single-use, disposable device • Make sure to clean the skin before inserting the needle • Throw away the used device in a sharps container right away. If you absolutely cannot avoid recapping, use a special one-handed technique or a resheathing device • Once full, seal the sharps container completely using a tamperproof lid • Before injecting, place the sample tubes in a stable rack to prevent spills and ensure control • If you experience a needle injury, take these steps: Report the incident, seek medical attention, and discuss post exposure prophylaxis (PEP) with a healthcare professional	• Never begin a procedure without cleaning your hands first • Never reuse gloves. One patient, one pair of gloves! • Don't risk contamination by reusing washed gloves. Washed Gloves = False Security! • Syringes, needles, and lancets are single-use for a reason. Don't risk infection by reusing. Fresh Sharps, Every Time! • Once disinfected, leave the puncture area untouched to prevent contamination. Hands off the Sterile Site! • Never leave a used needle unprotected. Dispose off it immediately in a designated sharps container. Sharps Container, Every Time! • Recapping needles with both hands is dangerous. Skip the Recap! • Never overfill or decant sharps containers. Fill It Right, Dispose It Safe! • Don't hold the sample tube while injecting. Double Trouble = Needle Stick Injury and Sample Contamination! • Don't wait! If you suspect exposure to contaminated material, see a healthcare professional right away to discuss PEP (Post-Exposure Prophylaxis). Starting PEP within 72 hours is crucial to prevent a serious infection

Figure 6.2 **Anatomy of needle**



Instructions for Safe and Effective Use

When using a sterile single-use injection device, it is important to follow specific guidelines:

- For each injection, ensure sterility by using a new, single-use device for both medication and vaccine preparation. This prevents contamination from previous uses and safeguards patient well-being
- Before using any device, carefully inspect the packaging for signs of damage that could compromise sterility. This includes checking for punctures, tears, or any indication of moisture exposure. If you notice any damage, discard the device properly and use a new one. Damaged packaging may indicate that the device has been compromised and is no longer sterile, potentially increasing the risk of infection
- Always check the expiry date on the packaging and discard any expired devices. Expired devices may no longer be sterile or effective, and using them could pose a risk to patient safety

Medication containers

Table 6.4: Types of medication containers and recommendation on their use

Type of container	Recommendation	Reason
Single dose vial	Preferred	Low likelihood of contamination
Multi dose vial	Only if unavoidable	High likelihood of contamination if aseptic technique is not followed
Ampoules	Pop-open preferred	Breaking a glass ampule may result in particulate matter escaping from the vial
Fluid or solution bags (100-1000 ml) for reconstitution	Not recommended for routine injection	High likelihood of contamination
Pre-filled saline flush syringes	Preferred for all types of flushing needs	Specially developed for flushing

Practical guidelines on administering medications[2]

- Using a new, sterile syringe for each patient and each medication dose
- Avoid medication errors and contamination by using a separate, sterile syringe for each vial reconstitution
- Don't hold onto leftover medication - dispose off it properly following recommended guidelines

Single-dose vials

- Whenever possible, choose single-dose vials to reduce medication waste and ensure accurate dosing for each patient
- Prevents contamination and reduces the risk of transmitting infections

Multi-dose vials

- Only use multi-dose vials if there are no alternatives available
- When using multi-dose vials, dedicate a single vial to each patient whenever possible. Label the vial clearly with the patient's name and store it in a designated treatment or medication room
- Make cleaning the rubber cap with alcohol a routine step before loading syringes. It prevents contamination
- Keep these vials in designated medication rooms or drawers, to ensure they remain sterile and safe for use
- Following medication withdrawal, promptly remove the needle from the multidose vial to maintain sterility and prevent contamination. Dispose off it in a sharps container

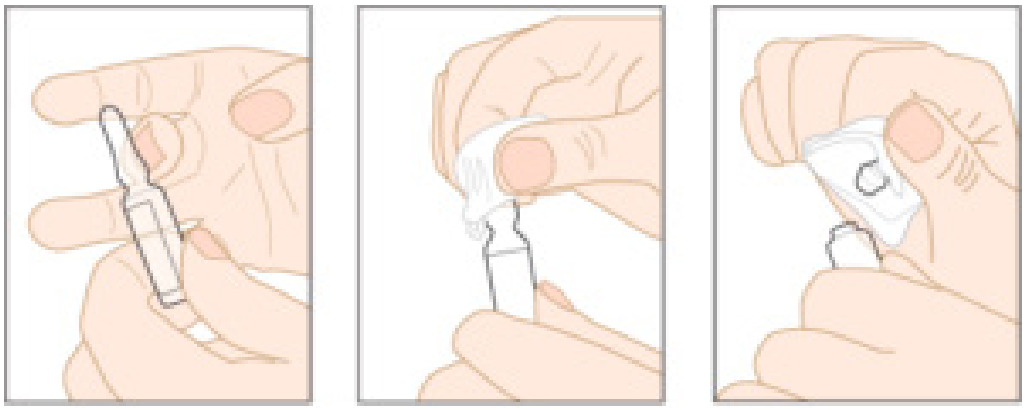
Discard a multi-dose vial If:

- The seal is broken or damaged (compromised sterility or content)
- The expiration date has passed. (expiry date or time has passed)
- It has been open longer than the recommended storage time. (not properly stored after opening, recommended time specified by the manufacturer has passed)
- It appears cloudy or discolored. (compromised sterility or content)

Pop-open ampoules

- When using ampoules with a file, score the neck gently with the provided file in a designated area. This ensures a clean break and minimizes the risk of spills or contamination
- For ampoules requiring a file, follow proper technique to score the neck cleanly

Figure 6.3 **Breaking open an ampoule with alcohol swab package around the neck of the ampoule** (Image source: BC Campus, Pressbooks, Chapter 7. Parenteral Medication Administration)



Tapping moves fluid down neck

Gauze pad placed around neck of ampule

Neck snapped away from hands

- Ampoules bearing red ring around the neck, have been scored already and have to be pressed gently with file

Preparing injections[2]

To ensure the aseptic preparation of injections and minimize the risk of contamination, a dedicated workspace is essential. This area should adhere to the following guidelines:

- Clean and organized environment:
  - Maintain a designated area specifically for injection preparation
  - Keep the workspace free from clutter to facilitate thorough cleaning and disinfection of all surfaces
  - Ensure surfaces are readily accessible for proper cleaning procedures
- Maintaining Sterility:
  - Prior to commencing each injection session, meticulously clean all surfaces with a 70% alcohol solution (isopropyl or ethanol)
  - Allow the cleaned surfaces to dry completely before proceeding with injection preparation activities
  - During the injection session, promptly clean any spills of blood or body fluids by using items and following steps advised in spill management protocol of the healthcare facility
- Preparation Supplies:
  Before initiating the injection session, verify the availability of all required sterile, single-use equipment:
  - Syringes
  - Needles
  - Arrange the appropriate reconstitution solution: Sterile water or specific diluent (as required)
  - Utilize alcohol swabs or cotton wool for disinfection
  - Keep a sharps container readily accessible for the safe disposal of used needles

By adhering to these guidelines, healthcare professionals can create a safe and controlled environment for preparing injections, minimizing the risk of contamination and ensuring patient safety.

Procedure for septum vials

- Prior to piercing the vial, use an alcohol swab (70% isopropyl or ethanol) to thoroughly wipe the access diaphragm (septum)
- Allow the area to air dry completely before proceeding. This ensures a sterile field for injection
- For each insertion into a multi-dose vial, use a fresh, sterile syringe and needle. This minimizes the risk of contamination between usage
- After withdrawing medication from a multi-dose vial, never leave the needle inserted. This helps prevent contamination of the remaining medication
- Once you've withdrawn medication with a sterile syringe and needle, administer the injection as soon as possible. This minimizes the risk of contamination from prolonged exposure

Labelling

Following reconstitution of a multi-dose vial, ensure the final medication container is clearly labeled with the following crucial information:

- Date and time of preparation: Record the exact date and time the medication was reconstituted
- Diluent details: If a diluent was used, specify its type and volume for accurate tracking
- Final concentration: Indicate the final concentration of the medication after reconstitution

- Expiry after reconstitution: Clearly mark the new expiry date and time for the reconstituted medication, following recommended guidelines
- Prepared by: Include the name and signature of the healthcare professional who reconstituted the drug for accountability

For multi-dose medications that don't require reconstitution, it's crucial to properly label the vial upon first use. Here's what the label should include:

- Date and time of initial access: Clearly mark the exact date and time the vial was first pierced. This establishes a reference point for monitoring the medication's shelf life after opening
- Pierced by: Include the name and signature of the healthcare professional who first accessed the vial. This promotes accountability and clear communication

Check for Allergies

Always ask patient about allergies, types of reactions, and severity of prior reactions.

Communicating with patients before, during and after administration

- Provide information to patient about the medication before administering it
- Answer questions regarding usage, dose, and special considerations
- Give the patient the opportunity to ask questions
- Include family members if appropriate

Administering injections [2]

Aseptic technique is a fundamental practice that should be followed for all injections to minimize the risk of infection and ensure patient safety. The following practical guidance provides a systematic approach to administering injections:

General

- Prior to administering an injection, refer to the drug chart or prescription to verify the medication, patient's name, and dosage
- Perform thorough hand hygiene before proceeding with the injection
- Cleanse the top of the vial with 60-70% alcohol (isopropyl alcohol or ethanol) using a swab or cotton-wool ball
- Open the package containing the syringe and needle in front of the patient to reassure them of its sterility
- Use a sterile syringe and needle to withdraw the medication from the ampoule or vial

Reconstitution

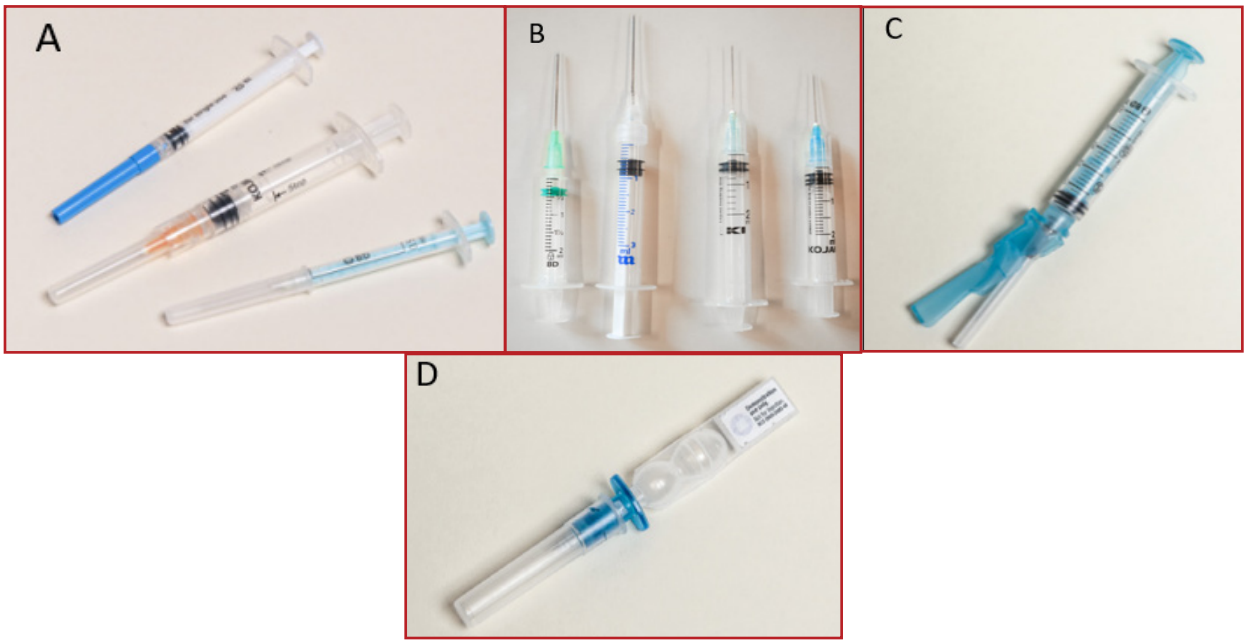
- If reconstitution is necessary, use a sterile syringe and needle to withdraw the reconstitution solution from the ampoule or vial
- Insert the needle into the rubber septum of the single or multidose vial and inject the required amount of reconstitution fluid
- Thoroughly mix the contents of the vial until all visible particles have dissolved
- After reconstituting the contents of a multidose vial, immediately remove and discard the needle and syringe

Needleless system

If a needleless system is available, follow these steps:

- Cleanse the rubber septum of the multidose vial with an alcohol swab
- Insert the spike of the needleless system into the vial
- Cleanse the port of the needleless system with an alcohol swab
- Retrieve a sterile syringe from its packaging
- Insert the nozzle of the syringe into the port and withdraw the reconstituted drug

Figure 6.4 **Auto disable syringes(A), Reuse prevention syringes (B), Sharps injury prevention syringes (C), Prefilled injection devices (D)**



Delay in administration

- If there is a delay in administering the dose, cover the needle with the cap using a one-hand scoop technique
- Safely store the device in a dry container, such as a kidney dish, to maintain its sterility

Routes of injection administration

Parenteral medications can be administered through four routes, each requiring specific skills and techniques:

- Subcutaneous (SC) Injection: Medication is injected into the tissue just below the skin
- Intradermal (ID) Injection: Medication is injected into the layer of tissue just beneath the outermost layer of the skin
- Intramuscular (IM) Injection: Medication is injected directly into a muscle
- Intravenous (IV) Injection: Medication is delivered directly into a vein using an IV line or a short venous access device. IV medications can be given rapidly, intermittently, or continuously

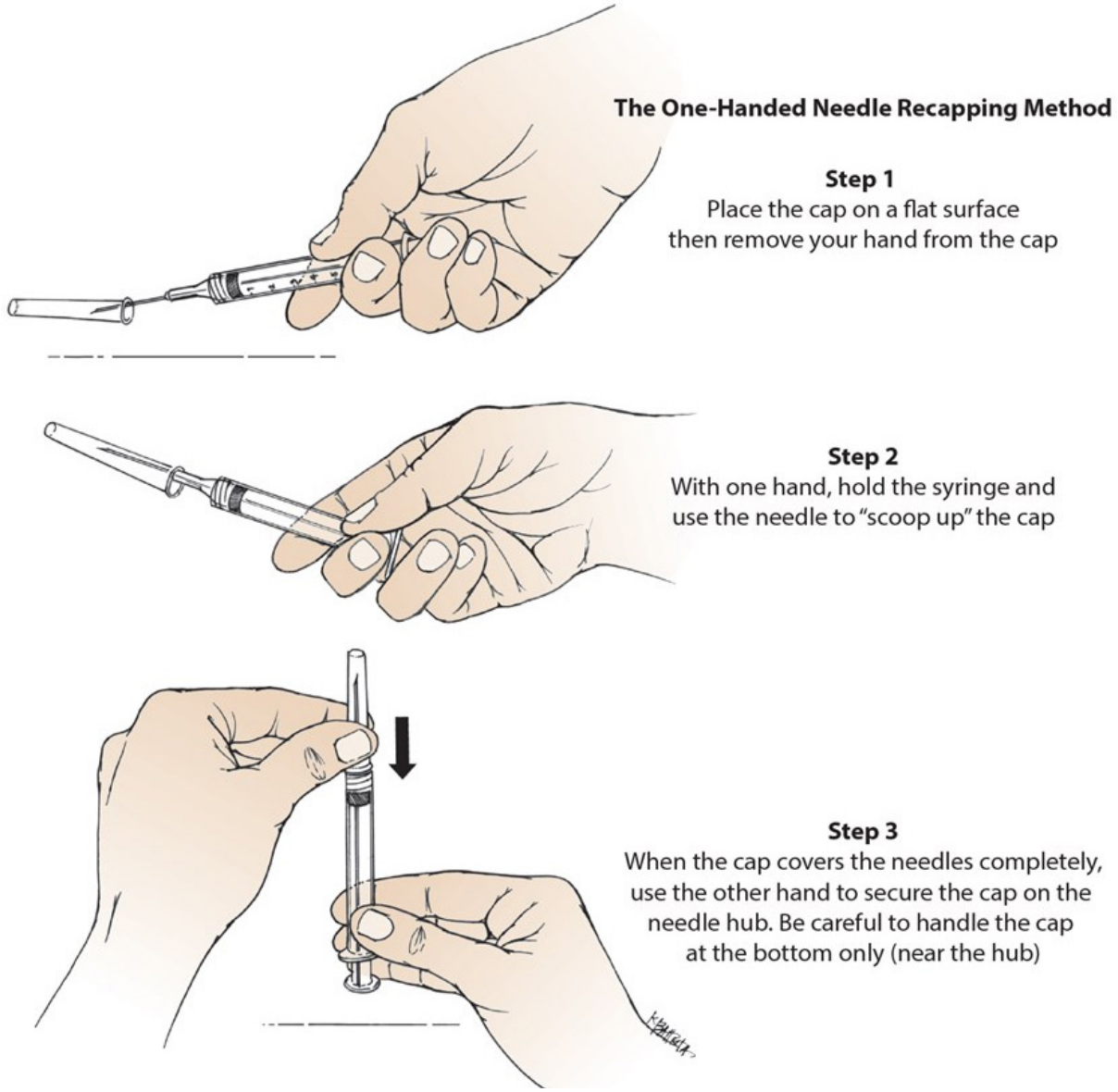
iii. Prevention of sharp injuries to Healthcare Workers [1, 2, 3]

Preventing Needle-Stick Injuries is crucial to ensure the safety of healthcare workers and minimize the risk of exposure to bloodborne pathogens. Here are some measures that can help prevent Needle-Stick Injuries:

a. Use safety-engineered devices [4-5]: Utilize safety-engineered needles and syringes that are designed to minimize the risk of accidental needle sticks. These devices often have built-in safety mechanisms such as retractable needles or needle shields. Some of the newer technologies are:

- **Auto disable syringes :** Auto-disable syringes are designed to become permanently disabled or locked after a single use. Once the plunger is fully depressed, a mechanism is triggered that prevents the syringe from being reused
- **Reuse prevention**: Reuse prevention syringes have either an automatic or an elective (user-initiated) disabling feature and either removable or non-removable needles. These syringes often have tamper-evident seals or indicators that show if the syringe has been

Figure 6.5 **WHO technique for method of single-handed needle recapping**
(Image source: Illustration by Kimberly Battista, Medical Illustration and Animation)



tampered with or used previously

- **Sharps injury prevention (SIP) syringes :** SIP syringes typically incorporate retractable needles or shielding mechanisms that minimize the chances of accidental needle sticks, providing an added layer of safety for healthcare workers
- **Prefilled injection devices :** Prefilled injection devices, also known as prefilled syringes or preloaded syringes, are ready-to-use syringes that come pre-filled with a specific dose of medication
- **Vacuum-based technology :** Vacuum-based technology for drawing blood is commonly used in healthcare settings and is known as evacuated blood collection systems or vacuum blood collection tubes. These systems utilize a combination of vacuum pressure and specialized collection tubes to facilitate the safe and efficient collection of blood samples
- **Safety needles and cannulas :** Safety needles and cannulas are specialized medical devices designed to minimize the risk of needle-stick injuries and enhance

safety during medical procedures. These devices incorporate various safety features to protect healthcare workers and reduce the potential for accidental needle sticks

b. Follow proper handling techniques: Always handle needles and other sharp instruments with care. Avoid recapping needles by hand, as this increases the risk of needle sticks. Instead, use a one-handed technique or a safety device to recap the needle

c. Dispose off sharps properly: Dispose off used needles and other sharps in designated puncture-resistant containers. Ensure these containers are readily available in healthcare settings and are easily accessible to healthcare workers

d. Implement safe work practices: Establish clear protocols and guidelines for safe needle use and disposal within healthcare facilities. Train healthcare workers on proper handling techniques and reinforce safe work practices regularly

e. PPE: Ensure that healthcare workers have access to and consistently use appropriate PPE, such as gloves, gowns, and face shields, to protect themselves from potential needle stick injuries and bloodborne pathogens

f. Education and training: Provide comprehensive education and training programs to healthcare workers on needle-stick Injury prevention, safe handling techniques, and the proper use of safety devices. Regularly update and reinforce this training to maintain awareness and compliance

g. Reporting and follow-up: Encourage healthcare workers to report all needle stick injuries promptly. Establish a system for investigating and documenting these incidents, including providing necessary medical evaluation, counselling, and follow-up

h. Needleless systems: Whenever possible, consider using needleless systems or alternatives to traditional needles for procedures that do not require direct needle access. These systems can help eliminate the risk of needle stick injuries altogether

i. Workplace safety culture: Foster a culture of safety within healthcare settings by promoting open communication, encouraging reporting of incidents and near misses, and addressing any identified risks promptly

iv. Sharp Waste Management:[2,6]

Improper collection and disposal of needles and syringes (N/S) can lead to various hazards: [1]

- Injuries to healthcare workers: Mishandling of used N/S increases the risk of accidental needlestick injuries, potentially transmitting infections
- Reuse by others: Improperly discarded N/S can be picked up and reused by others, spreading blood-borne infections
- Accidental pricking of children: Children may come across improperly disposed N/S, leading to accidental injuries and potential infection transmission
- Resale of used N/S: Improper disposal allows for the resale of contaminated N/S, contributing to infection transmission
- Community objections: Improper disposal may trigger community outrage and objections
- Proper collection, storage, and disposal of N/S are essential to mitigate these hazards
- Use of sealed, puncture and leak-proof sharps containers helps to prevent access to used devices

Practical guidance on waste management [2]

To ensure that waste is dealt with safely:

- Transport and store sharps containers in a secure area before final disposal
- Close, seal and dispose off sharps containers when the containers are three quarters full; assign responsibility in written policy for monitoring the fill level of sharps containers and replacing them when three quarters full
- Discard waste that is not categorised as sharp or infectious in appropriate colour-coded bags

- Ensure that infectious waste bags and sharps containers are closed before they are transported for treatment or disposal

Injection safety checklist [7]

The following Injection Safety checklist items are a subset of items that can be found in the CDC Infection Prevention Checklist for Outpatient Settings: Minimum Expectations for Safe Care. The checklist should be used to systematically assess adherence of healthcare providers to safe injection practices. Assessment of adherence should be conducted by direct observation of healthcare personnel during the performance of their duties.

Unsafe injection practices [2–4]

Unsafe injection practices refer to actions or behaviours during the administration of injections that deviate from established guidelines and pose a risk of harm or infection transmission. These practices can lead to adverse outcomes for patients, healthcare providers, and the community. Examples of unsafe injection practices include:

- Reusing disposable syringes or needles
- Sharing needles or syringes among individuals
- Using non-sterile or expired injection equipment

Table 6.5: Injection safety checklist[8]

Injection safety	Practice performed?		If answer is no, document plan for remediation
Proper hand hygiene, using alcohol-based hand rub or soap and water, is performed prior to preparing and administering medications	Yes	No	
Injections are prepared using aseptic technique in a clean area free from contamination or contact with blood, body fluids, or contaminated equipment	Yes	No	
Needles and syringes are used for only one patient (this includes manufactured prefilled syringes and cartridge devices such as insulin pens)	Yes	No	
The rubber septum on a medication vial is disinfected with alcohol prior to piercing	Yes	No	
Medication vials are entered with a new needle and a new syringe, even when obtaining additional doses for the same patient	Yes	No	
Single-dose or single-use medication vials, ampoules, and bags or bottles of intravenous solution are used for only one patient	Yes	No	
Medication administration tubing and connectors are used for only one patient	Yes	No	
Multi-dose vials are dated by healthcare workers when they are first opened and discarded within 28 days unless the manufacturer specifies a different (shorter or longer) date for that opened vial. Note: This is different from the expiration date printed on the vial	Yes	No	
Multi-dose vials are dedicated to individual patients whenever possible	Yes	No	
Multi-dose vials to be used for more than one patient are kept in a centralized medication area and do not enter the immediate patient treatment area (e.g., operating room, patient room/cubicle) **Note:** If multi-dose vials enter the immediate patient treatment area, they should be dedicated for single-patient use and discarded immediately after use	Yes	No	

- Failing to properly clean and disinfect injection sites
- Administering injections without proper training or competence
- Contaminating medication vials or ampoules during preparation
- Inadequate infection control practices during injections
- Lack of awareness or adherence to safe injection guidelines
- Using contaminated or non-sterile solutions for injections
- Improper handling or storage of medications leading to contamination

Diseases associated with unsafe injection practices [1, 2, 3, 5–7]

Unsafe injection practices can lead to the transmission of various infectious diseases. Here are some examples of diseases that can be caused by unsafe injection practices:

- Hepatitis B (HBV)
- Hepatitis C (HCV)
- Human Immunodeficiency Virus (HIV)
- Bacterial infections
- Soft tissue and skin infections
- Bloodstream infections
- Viral infections

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Contents of this Chapter

Chapter 7

Cleaning and Spill Management

Picture Credit: AIIMS, New Delhi

Cleaning and Spill Management

The hospital environment serves as a reservoir for the transmission of microorganisms.[1] Exposure to microorganisms in the environment can lead to illness in both patients and healthcare professionals. Contaminated surfaces, especially the frequently touched surfaces are reservoirs for microorganisms and contribute towards pathogen transmission.[2] Many pathogens have been found to survive for days or even months in the environment.[3] The person to person contact (direct) transmission is the most likely mode of infection spread. However, surfaces play an important role in indirect transmission and must not be overlooked.[4]

Figure 7.1 **Contact transmission pathway illustrating the contribution of surfaces, environment and hand hygiene to breaking the transmission chain**
(Image source: CDC)

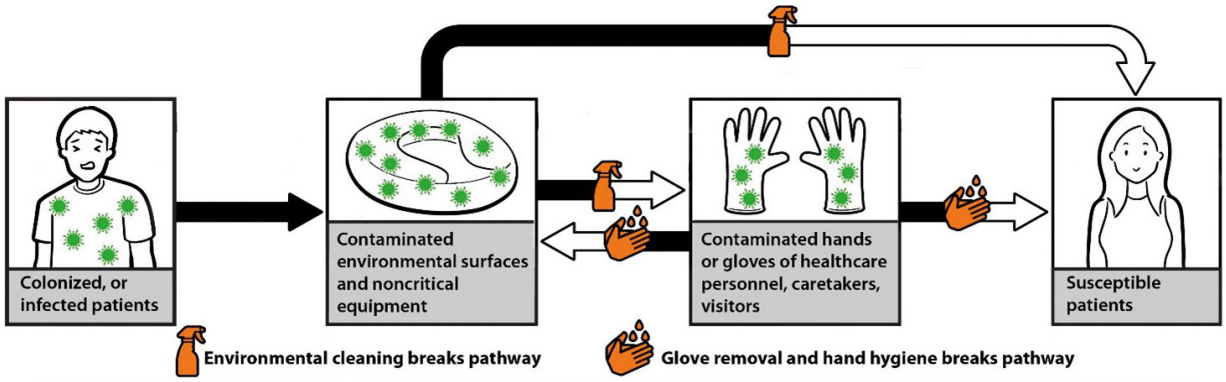


Table 7.1: Definitions

Cleaning	Physical process of removal of dust, soil, blood, and other body fluids using friction essentially removing debris and germs. It is accomplished with water, detergents, and mechanical action
Contamination	The presence of germs on hands or a surface such as clothes, gowns, gloves, bedding, toys, surgical instruments, patient care equipment, dressings, or other inanimate objects
Cross-contamination	Cross-contamination is the transfer of harmful germs from one person, object or place to another.

Disinfectant	A product that is used on surfaces or medical equipment/ device which results in disinfection of the equipment/device.
Disinfection	Process of complete elimination of vegetative forms of microorganisms except bacterial spores from inanimate objects.
Detergent	A synthetic cleansing agent that can emulsify and suspend oil. It contains surfactant or a mixture of surfactants with cleaning properties in dilute solutions to lower surface tension and aid in the removal of organic soil and oils, fats, and greases.
Dry mopping	Process of removing dirt/debris from the floors using mop head alone without using water or detergent.
Environmental cleaning	Cleaning and disinfection of healthcare facility environment including the contact surfaces (e.g., bed rails, mattresses, call buttons, chairs) and surfaces of noncritical patient care equipment (e.g., IV poles, stethoscopes etc).
High dusting	Dusting of all horizontal surfaces and fixtures over shoulder height, including vents, is considered high dusting. To lessen the chance of inhaling dust particles, the patient or resident should ideally be out of the room during high dusting.
Isolation precautions	Infection control interventions used to reduce the risk of transmission of germs to patients and hospital staff.
Terminal cleaning	The thorough cleaning of the inpatient room following the discharge of the patient in order to remove germs that can possibly be transferred to the next patient in the room.
Three-bucket system (mopping)	Floor mopping system for cleaning and disinfection. The first bucket contains water with detergent in which the mop is first dipped. The mop is then rinsed in the second bucket (for clean wringing) and dipped into the third bucket (for dirty wringing) which can also contain a disinfectant, before mopping the floor.
Wet mopping	Floor cleaning using water and detergent or disinfectant.

Some basic concepts in cleaning

a. Hospital and Hotel clean

Depending on the patient requirement and the risk of infection from the area, health care setting should be hotel clean or hospital clean or both.[5]

Hotel clean	Hospital clean
Hotel Clean is measured based on the visual appearance that includes dust and dirt removal, waste disposal and cleaning of windows and surfaces. Hotel clean is the basic cleaning mandatory for the whole health care setting.	Hospital Clean is additional cleaning measures like increased frequency, disinfection and other infection control practices and auditing along with the 'Hotel Clean' in select areas of a health care setting

Components of Hotel cleaning[5]

- Absence of visible dust, stains, spills and streaks from floors and baseboards
- Absence of visible dust, gross soil, spider webs and hand prints from walls, doors and ceilings
- All horizontal surfaces are free of visible dust, streaks, soiling and stains (includes furniture, windows, window ledges, overhead lights, phones, picture frames, carpets etc.)
- Bathroom fixtures including toilets, sinks, tubs and showers are free of streaks, soil, stains and soap scum
- Mirrors and windows are free of dust and streaks
- Dispensers are free of dust, soiling and residue and are replaced/replenished when empty
- Waste is disposed off appropriately
- Broken or malfunctioning items are replaced

b. Risk categorization of hospital areas

Healthcare environments in different patient care areas should pose risk to patients, care providers, staff and visitors. However, different hospital areas have different degrees of risk and, therefore, require different cleaning frequencies, as well as different levels of monitoring and evaluation. Hospital areas may be grouped into one of the three risk categories i.e., high risk, moderate risk, or low risk.

High-touch surfaces are defined as a potential reservoir of infectious agents and contamination of which can pose a high likelihood of the spread of pathogens comprising even of the Multi-Drug-Resistant organisms, hence it is recommended that these surfaces are to be cleaned and disinfected more frequently than low touch surfaces.[7]

Table 7.2: Risk categorization of Hospital areas[6]

HIGH RISK AREAS	MODERATE RISK AREAS	LOW RISK AREAS
• Operation theatre units including recovery area: major and minor • Intensive Care Units/Cardiac Care Units/ Neonatal ICU etc. • High Dependency Units • Emergency Department/Casualty • Labour room • Post operative units • Surgical wards • Central Sterile Supply Department/ Theatre Sterile Supply Unit • Radiation treatment areas • Chemotherapy ward/room • Renal dialysis facility • Burns units. • Isolation wards/ rooms and attached internal areas like bathrooms/toilets	• Medical and allied wards • Laboratory areas • Blood bank • Pharmacies • Dietary services • Laundry services • Mortuary • Nurses/Doctors restrooms • Rehabilitation areas • Psychiatric wards	• Department areas/ office areas • Outpatient department • Non-sterile supply areas • Libraries • Meeting rooms • Medical record section • Stores section • Manifold services room • Telephone room, electrical, mechanical, external surroundings • Staff areas

Note: Adjuvant areas i.e., storage/ changing room/ toilets and corridors of the respective areas fall in the same risk categories

Table 7.3: High touch areas[8]

Patient room High Touch Areas[8]	Patient restroom High Touch Areas	High Touch Areas - Wards
• Bed rails • Bed frames • Handles • Bedside table • Tray table • Moveable lamps • IV poles • Blood-pressure cuff	• Toilet seat • Toilet handle • Toilet handle rails • Restroom light switch • Restroom door handle - interior and exterior • Bathroom sink	• Wheelchair handles • Chairs and tables • Switch-board • Nursing station • Door handles and push plates

Low-touch surfaces are surfaces that have minimal contact with hands. Examples include (but are not limited to) floors, walls, ceilings, mirrors, and window sills.

Figure 7.2 **High frequency hand touch surfaces and surfaces potentially contaminated with blood and body fluids** ***(Image source: WHO)***

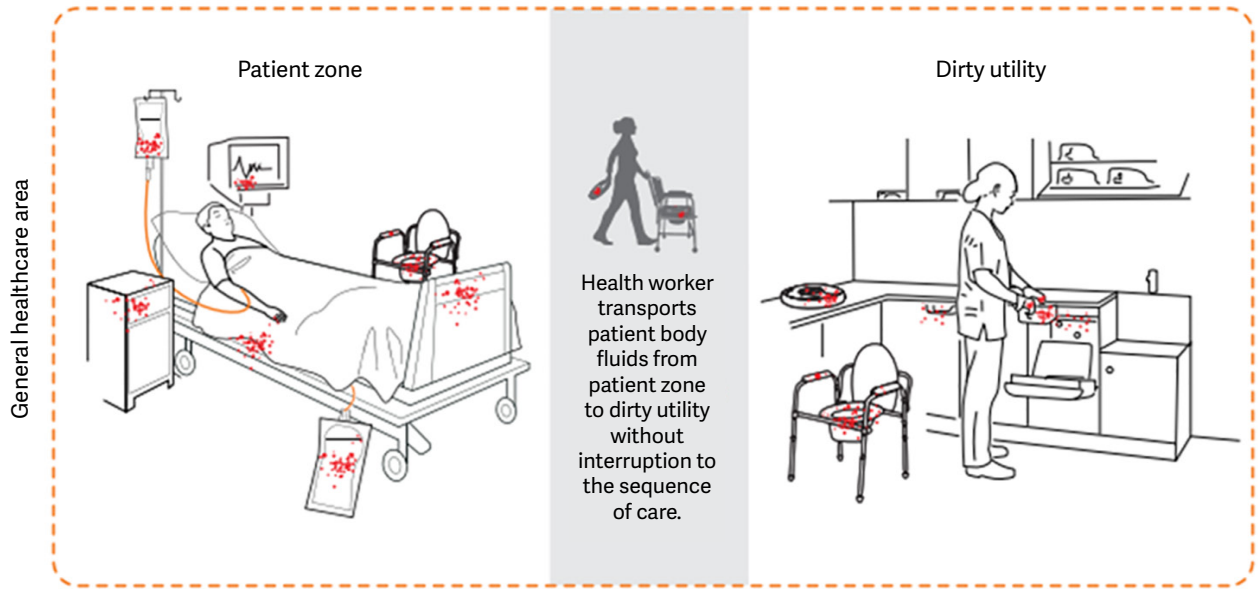


Figure 7.3 **High touch items and surfaces in an HCF**[9] ***(Image source: PIDAC)***

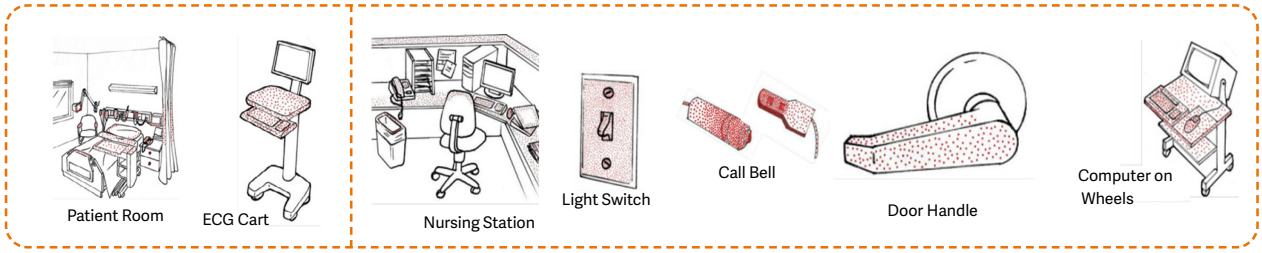
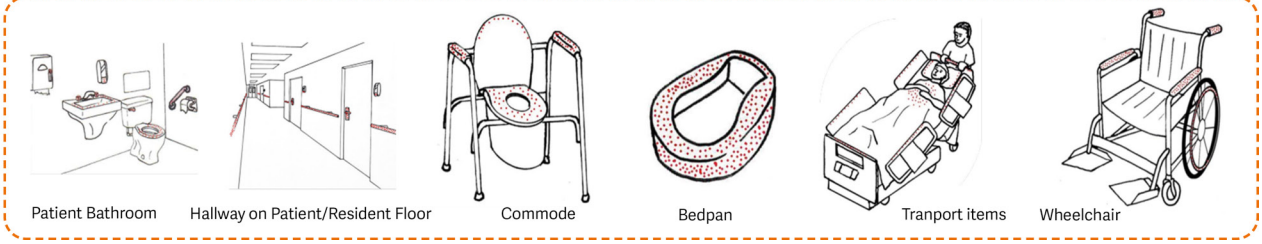


Figure 7.4 **High touch items and surfaces in an HCF[9]** ***(Image source: PIDAC)***



Preparation for cleaning

Various areas of a Healthcare Facility demand varying degree of cleanliness, e.g., the Out Patient Department (OPD) and patient waiting areas do not require a comparable level of cleanliness as high as the Operation Theater or ICU. **Wherever feasible, wet mopping is preferred over dry sweeping to prevent stirring up and circulation of dust and allergens.**

Table 7.4: General Steps to be followed during cleaning

Preparation
• Put on PPE: Gloves, head cover, shoe cover • Prepare cleaning solution in the wringer bucket and the plastic pail as per the dilution directions mentioned by the manufacturer on the product label • Move cots and furniture to one side • Scrape off sticky or dried up soil on the floor using scrapping sheet
Performance
• Sweep the floor using dust control mop towards the doorway, collect it in a dustpan, and throw it away in the garbage • Wet the mop with the prepared cleaning solution and carefully wring it out to ensure that there is enough solution in the mop to clean the floor as needed • Ideal direction to wet mop the floor is from the centre toward the entrance • Water used for mopping should be changed often, especially if it is visibly unclean
Direction
• The sweeping movement should be unidirectional • Proceed from cleaner to dirtier for eg., clean patient care areas like inpatient zones before patient toilets • Proceed from upwards to below to avoid dirt and microorganisms from falling or dripping and contaminating already cleaned areas. for e.g., clean the bed railings before the bed legs • Follow a systematic approach to prevent areas from being missed out. e.g., left to right or clockwise • Make hand-touch sites a priority • Damp cloth should be used for dusting to ensure minimal dispersion of dust • These are to be used turn-wise, providing a fresh and clean surface for successive usage
Finishing
• Dispose off PPE in colour coded containers as per BMW Rules • Remove your cap and mask • Wash your hand as per six steps

Table 7.5: Types of Cleaning[10]

Term	Definition	Cleaning and/or disinfection requirement and frequency	Products
In-depth enhanced cleaning	Cleaning method to be adopted when there is a patient infected (confirmed or suspected) with a Carbapenem-resistant organism (CRO) especially during an outbreak of CROs (or at the request of the IPC team)	• Thorough cleaning using detergent and drying, followed by disinfection of high frequency hand touch surfaces and surfaces with high contamination risk within the area (this includes but not limited to the sluice/ dirty utility room, toilets, bathrooms and any area possibly contaminated with a patient's faecal organisms, including CROs) • Multiple times a day • If there is a higher risk of environmental contamination due to spillage via blood and body fluids the frequency of cleaning should be further increased • Isolation areas should be cleaned after proper cleaning of non-isolation patient care zones	• Neutral detergent, followed by a freshly prepared disinfectant solution of Sodium Hypochlorite (1000 ppm) or alcohol wipe (at least 75%), for e.g., isopropyl, ethyl-alcohol • Do not use peracetic acid (not considered safe for routine environmental cleaning) • Blood/body fluid spills are to be managed as per regional guidelines
Routine/ Standard cleaning	Cleaning employed routinely to prevent the transmission of microorganisms that may cause HAIs	• It involves the use of neutral detergent, with disinfectant for high frequency hand touch surfaces • Frequency: usually once a day or once in each shift (for areas functioning round the clock) or immediately when soiling or spills of blood/body fluid	• Neutral detergent • For high frequency hand touch surfaces, use neutral detergent followed by a freshly prepared disinfectant solution of sodium hypochlorite (1000 ppm) or alcohol wipe (75% atleast), for example, isopropyl, ethyl alcohol
Terminal Cleaning (Discharge/ transfer cleaning)	Cleaning of the patient zone undertaken following the discharge/ transfer of any patient	• In addition to routine cleaning, it includes cleaning of some low frequency hand touch surfaces (emphasis on horizontal surfaces) and high frequency hand touch surfaces that are not accessible when the room is occupied (for e.g., the patient mattress). It also involves the removal of bed linen, disposable patient item and reprocessing (cleaning and disinfection) of any dedicated patient care equipment	

Standardized cleaning protocols

Cleaning of Patient Care Room/Area

Patient care areas and rooms should be cleaned according to a systematic, planned format that incorporates the components listed below.

A) Daily Routine Patient Bed Space/Room Cleaning[11]

Assessment	• Check for any precautions signs/instructions to be followed in the area and follow accordingly • Consider replacing any essential supplies (such as toilet paper, paper towels, soap, gloves, garbage/ BMW bags and sharps container etc.) prior to, during and after cleaning process
Gather supplies	• Ensure adequate supply of clean clothes • Prepare fresh solution of disinfectant based on the hospital infection control protocol
Wash hands as per protocol and put on an appropriate PPE	
Clean room: work from clean to dirty and high to low areas of the room	• Use fresh cloth(es) for cleaning each patient's bed space • If a bucket is used, do not 'double dip' cloth(es) • Do not shake out cloth(es) • Change the cleaning cloth after cleaning heavily soiled areas and when the solution is no longer saturated with disinfectant • Start by cleaning doors, door handles, and touched areas of frame • Inspect walls for visible soiling and clean periodically and when deemed appropriate. Clean switches and thermostats • Clean wall mounted items like Alcohol-Based Handrub dispenser • Inspect and remove handprints and soil from lower portions of interior glass partitions, glass door panels, mirrors and windows using glass cleaner • Inspect curtains for visible soiling and replace, if required • Clean all horizontal surfaces and the furnishings in the room such as chairs, window sill, television, telephone, computer keypads, over bed table etc • Items to be lifted or removed for cleaning the table • Due attention to be paid to high touch surfaces • Wipe wall mounted equipments like the top of suction bottle, intercom, and blood pressure manometer and IV pole • Clean bedrails, bed control remote and patient call bell • Clean bathroom/shower when applicable (please refer to bathroom cleaning procedure) • Clean floors (please refer to floor cleaning methods)
Disposal	• Collect the soiled clothes in designated container bag for laundering • Place waste in colour coded bins as prescribed under biomedical waste management rules • Do not dust the top of a sharps container • Remove waste
Remove gloves and wash hands with soap and water. Do not leave the room wearing soiled gloves.	
Replenish supplies as per the requirements (e.g., gloves, soap, tissue roll/paper towel, BMW bags, cardboard box etc.)	

B) Procedure for Routine, Discharge/Transfer Cleaning of a Patient Bed Space/Room[9, 11]

Assessment (as mentioned above)	
Gather supplies	
Wash hands and put on appropriate PPE	
Remove dirty linen	• Take off the sheets and put them in a dirty laundry bag. Roll them up neatly to avoid stirring up dust • Inspect the curtains and blinds by the bed. If they look dirty, swap them out for clean ones • Take off the gloves and wash hands well
Clean room:	• Work from clean to dirty and high to low areas of the room • Cleaning of floors has to be done at a later stage
Clean the bed	• Clean the top and sides of mattress, turn over and clean underside • Inspect for pest infestations and control measures • Clean headboard, footboard, bed rails, call bell and bed controls • Pay due attention to areas that are visibly soiled, and surfaces frequently touched by staff • Clean all lower portions of the bed frame, including castors • Allow mattress to dry
Clean bathroom/shower	(as mentioned subsequently)
Clean floors	(as per floor cleaning procedure)
Disposal	(as mentioned above)

- Remove gloves clean hands with ABHR
- If hands are visibly soiled, wash with soap and water
- Do not leave the room wearing soiled gloves

Remake bed and replenish supplies as per the requirement (e.g., gloves, soap, paper towel, toilet brush)
Inspect the cleaned equipment (e.g., IV poles and pumps, walkers, commodes) and return to clean storage area

Terminal cleaning of an area

A terminal cleaning is defined as a procedure necessary to make certain that, after a patient with an infection or communicable disease is discharged, the area has been cleaned or decontaminated to ensure a safe environment for the incoming patient.

- Bed screens, curtains and bedding should be removed prior to the room/area being decontaminated
- Disinfectants like sodium hypochlorite need to be used when there is a chance of environmental contamination. Organic soil must be removed from the surface being decontaminated in order for disinfectants to function properly
- The environment should be cleaned with a neutral detergent solution before disinfection, or a detergent and disinfectant mixture may be used

Procedure for Terminal Cleaning

- All items within the room need to be cleaned using an appropriate hospital disinfectant
- When removing the linen from the bed, caution should be taken to avoid shaking it. Linen should be folded away from the person and folded inward into a bundle, then removed with least agitation
- When appropriate, empty all reusable containers, such as bedpans, urinals, drainage bottles, etc., and disinfect them with 1% sodium hypochlorite solution
- IV poles, ventilators, and suction machines, among other equipment that shouldn't be thrown away, should all be properly cleaned with 1% sodium hypochlorite solution
- When appropriate, disinfect mattresses and pillows with long-lasting plastic covers by using a 1% sodium hypochlorite solution mixed with 75% alcohol
- The recommended disinfectant for beds and furniture is 1% sodium hypochlorite solution
- After the trash has been removed, the BMW and waste bin should be thoroughly cleaned with phenolics (5% carbolic acids) or 1% sodium hypochlorite solution
- Walls and ceilings need not be washed entirely, but areas that are obviously soiled should be disinfected with 1% Sodium Hypochlorite solution

Routine bathroom cleaning *(clean areas to dirty areas)*

- Clean the floor of any soiled linen, remove any spills, and remove waste
- Clean door handle and frame, light switch
- Clean chrome wall attachments
- Clean the exterior and interior of the sink, the faucets and mirrors beneath it, the plumbing beneath it, and the interior of the sink with disinfectant. Guarantee a sufficient duration of contact with the disinfectant
- Clean the sink and dry the fixtures
- Clean all dispensers and frames
- Clean call bell and cord
- Clean support railings, ledges and shelves
- Clean shower, faucets, walls and railing, scrubbing as required to remove soap scum
    - Make sure the disinfectant has enough time to come into contact with the surfaces inside the shower, such as the shower head, faucets, and soap dish. Then, rinse and wipe the area dry
    - Check shower curtains for wear and tear periodically and replace them as needed
- Ensure the toilet, handle, bedpan support, and underside of the flush rim are clean. Give the disinfectant enough time to come into contact with the surface
- Remove gloves and wash hands
- As needed, replenish the supplies including: paper towels, toilet paper, trash bags, soap, and ABHR
- Report and replace any sections that are broken, leaky, or damaged

Mopping Floors (Working from clean areas to dirty areas):

Note: Follow ergonomics for better safety of HCWs

Mopping Floors using Dust Control Mop (microfiber)

- Clear the floor of any debris, and use paper towels to dry any damp areas
- Remove gum or any other sticky residue from floor
- Working in straight, slightly overlapping lines and maintaining full contact between the mop head and the floor, start in the furthest corner of the room and drag the mop toward you before pushing it away
- Once you begin, do not pick up the dust mop off the floor; instead, turn the mop by swiveling the frame and wrist
- After dusting, move and reposition the furniture, including behind and beneath the beds
- Carefully dispose off debris, being careful not to stir up dust
- Replace the mop head or pad if it becomes soiled and after cleaning a room

Mopping Floors using Wet Loop Mop and Bucket

- As per instructions of the manufacturer, make a fresh cleaning solution using the appropriate PPE in accordance with the Material Safety Data Sheet (MSDS) or hospital policy
- Put down 'wet floor' caution signage outside the room or area while being mopped
- Divide the area into parts (e.g., Corridors shall be divided into halves, lengthwise, such that one side is open for Traffic movement while the other is being cleaned)
- Submerge the mop in cleaning solution, then wring out
- Push mop around skirtings first, paying particular attention to removing soil from corners; avoid splashing walls or furniture
- Use the figure of eight stroke technique in open, spacious areas, overlapping each stroke; when mopping in a single direction, after five to six strokes turn the mop head over
- When cleaning in limited spaces, start from the farthest corner of the room, dragging the mop toward self, and pushing it away, ensuring complete contact between the floor and the mop head in a series of parallel, slightly overlapping strokes

Mopping Floors using a Microfiber Mop

- Pour cleaning solution into plastic bowl
- Put the microfibre pad(s) in the basin to soak
- Pick a clean pad from the basin, wring out and use velcro strips to secure it to the mop head
- Once the pad gets dirty, remove it and put it aside for laundering
- Use a fresh microfiber pad for each room
- At the end of the day, send reusable soiled microfiber pads for laundering

Cleanroom mopping

Cleanroom mopping is simple yet complex and important to know. There are many techniques for cleanroom mopping, so let us break it down.

Figure 7.5 Figure of 8 stroke technique for mopping [12] (Image source: Angstrom Supply Cleanroom)

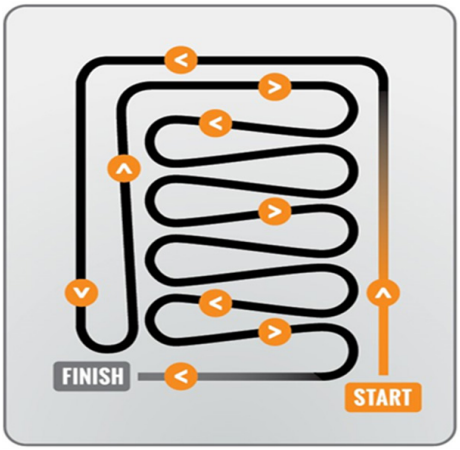


Figure 7.6 Lift and pull technique

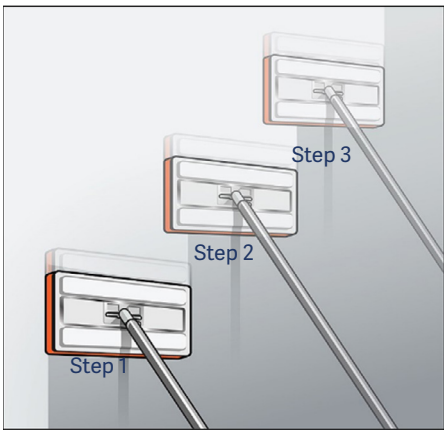


Figure 7.7 Ergonomic mopping for HCW to avoid any injury [13] (Image source: Microfiber Wholesale)

Table 7.6: Bucket System

How to Clean a Cleanroom: Using Multiple Bucket Systems[12]

Two Bucket System

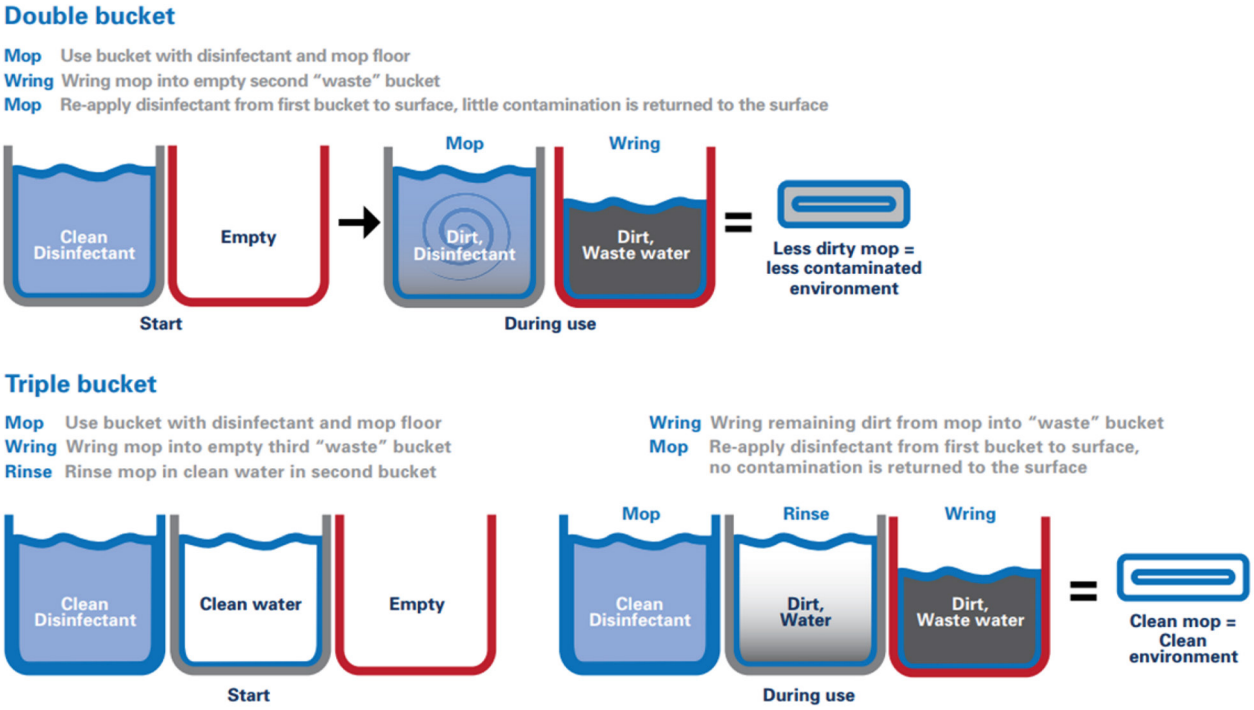
A double bucket system involves use of 2 buckets, The first bucket has the clean water and the second bucket is used to squeeze out the waste water from the used mop following which the mop is dipped in clean water and the mopping is done.

- Clean Solution Bucket – Pour the cleaning solution into the first bucket. Dip the mop and ensure it is saturated in the solution
- Waste Bucket – – Wring the excess cleaning solution from the mop into the second bucket
- Mop – Using the suitable mopping technique with even and overlapping strokes, apply the appropriate amount of solution to the surface
- Waste Bucket – After few strokes or when the mop is visibly dirty, dip it again into the waste bucket and wring the wastewater
- Repeat this until all of the surfaces are mopped

Three Bucket System [14]

- A three-bucket cleaning method involves use of three buckets, the first clean solution bucket dedicated for sanitation, a second bucket for clean wringing, and a third bucket for dirty wringing
- Clean Solution Bucket (first bucket)– Pour the cleaning solution to the first bucket. Dip the mop and ensure it is saturated in the solution
- Waste Bucket – Wring the excess cleaning solution from the mop into the second bucket. Make sure the pressure is at the right level to prevent the cleaning solution from being overly or underly removed from the mop head
- Mop the Surfaces – Using the suitable mopping technique with even and overlapping strokes, apply the appropriate amount of solution to the surface
- Waste Bucket – Wring the mop into the waste bucket once the solution is no longer suitable or when mopping is completed in accordance with the SOP
- Rinse Bucket – Rinse the mop in the third bucket, which is filled with the same disinfectant solution in the same ratio as the first bucket containing the clean solution
- Waste Bucket – wring the mop head into the waste bucket again
- Rinse the mop in the third bucket, which is filled with the same disinfectant solution in the same ratio as the first bucket containing the clean solution. Repeat steps 1-6 until all the surfaces are mopped

Figure 7.8 **Bucket System**[15]



Operating Room

Operating rooms are the highly specialized spaces where surgical procedures are carried out in a mechanically controlled atmosphere. It is essential that these areas undergo environmental cleaning at three distinct instances throughout the day:

- Before the first procedure
- Between two successive procedures
- After the last procedure (i.e., terminal cleaning)

Table 7.7: Procedure for cleaning of operating rooms

First cleaning of the day (before cases begin)

- Irrespective of whether planned to be used or not, routinely clean and disinfect the operating room in the morning
- Wash hands and wear PPE
- Clean and disinfect the areas of the room and the items:
  - All flat surfaces (wipe from top to bottom, then from the centre outwards)
  - OT table and its attachments, positioning devices, and patient transfer devices
  - Containers for sterile instruments, antiseptic bottles, and the trays in which these are kept
  - Scrub basins, taps, and walls. Check for any leaks
  - The soap and antiseptic solution bottles at the scrub station. Make sure they are filled, and replenish them when necessary. If the operating theater has a temperature control, this can be done the evening before

- Prepare BMW bins by placing the appropriate colour-coded waste collection bags
- In the end, clean and disinfect the floor. Using a mop or a hospital-grade wet vacuum, remove any dirt and dust. Then, mop with clean water to prevent any soap residue. Finally, mop with disinfectant. Minimise agitation to prevent stirring up and spread of dust
- After the operating room has been cleansed and disinfected, leave the door closed and turn on the ventilation for 10-15 minutes

Cleaning Operating Rooms in between Cases

- Place a cautionary 'Wet Floor' signage at the entry to the room
- Prepare fresh disinfectant solution
- Wash hands and put on PPEs
- Collect and remove waste
- Collect and remove all soiled linen
- Remove gloves and clean hands
- To clean and disinfect surfaces that have come in contact with a patient or bodily fluids, use a cloth dampened with hospital-grade disinfectant solution as per hospital policy. (ie., blood pressure cuffs, tops of surgical lights, tourniquets, and leads)
- Clean suction canisters, reflective portion of surgical lights
- Clean and disinfect OT table
- Clean electronic equipment as per the manufacturer's instructions (ie., monitors)
- Damp mop floor in a 1 to 1.3 metre (3 to 4 feet) perimeter around the OT table (Larger area if contamination present)
- Insert colour coded bags in waste bins
- Damp-dust the equipments from other areas before being brought into the operating room and prior to leaving (ie., X-ray machines, C-arm etc.,)
- Remove gloves and clean hands, once the cleaning is completed

End of the day operating room cleaning

- Place a cautionary 'Wet Floor' signage at the entry to the room
- Prepare fresh hospital-grade disinfectant solution as per the manufacturer's instructions/as per hospital protocol
- Clean hands and put on PPEs
- Collect and remove waste
- Collect and remove all soiled linen
- Clean hands and change gloves
- Clean and disinfect lights and ceiling-mounted tracks
- Clean and disinfect all door handles, push plates, light switches and controls
- Clean and disinfect telephones and computer keyboards
- Spot-check walls for cleanliness
- Clean and disinfect all exterior surfaces of machines and equipment (e.g., anaesthesia carts), allowing adequate drying time for the disinfectant before storage
- Clean and disinfect all furniture including wheels/casters
- Clean and disinfect exterior of cabinets

- Clean and disinfect all surfaces
- Clean scrub sinks and surrounding walls
- Mop the floor, ensure floor is washed underneath the OT table, moving it aside; Move all furniture to the center of the room and finish mopping. Use a fresh mop or mop head and fresh solution in each area. Apply adequate disinfectant or detergent to keep the floor damp for five minutes. Place all furniture and equipment back in their designated places
- Wash the colour coded bins, dry them and insert appropriate colour coded bags once they are dried
- Report any requirements of repairs
- Clean and store cleaning equipment
- Remove gloves and clean hands

Procedure for cleaning operating room[8]

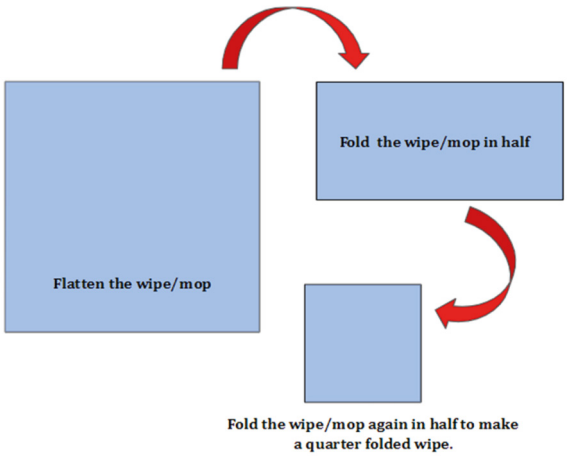
Environmental cleaning in surgical settings minimises Patient's and Healthcare Provider's exposure to potentially infectious micro-organisms.

Specialty Equipment Cleaning Recommendations

- Materials needed include hand mops, utility gloves, and disinfectant working solution
- Before beginning, gather all supplies and prepare them. For equipment and environmental surfaces like floors and walls, use separate mops
- Put on heavy utility gloves
- Pour the cleaning solution or disinfectant on the mop. The amount that needs to be poured should be adequate to maintain the freshly cleaned surface damp for two minutes (Except in case of soap and water, which should be allowed to dry at the earliest)
- Sweep the mop in a single direction across the equipment's surface. Press down to put adequate pressure on the wipe. Do not return to the area that was cleaned
- Always begin cleaning from the top of the equipment and proceed downwards (top to down)
- Change the fold of the mop as you go from one part of the equipment to the next, then continue mopping after adding more disinfectant or cleaning solution
- Once all the folds of the mop have been used up, keep it aside to be washed and use a new mop. Switch out the mop whenever the room is changed
- Allow the disinfectant/cleaning solution to dry naturally
- Do not rinse the mop in water while cleaning the equipment

Figure 7.10

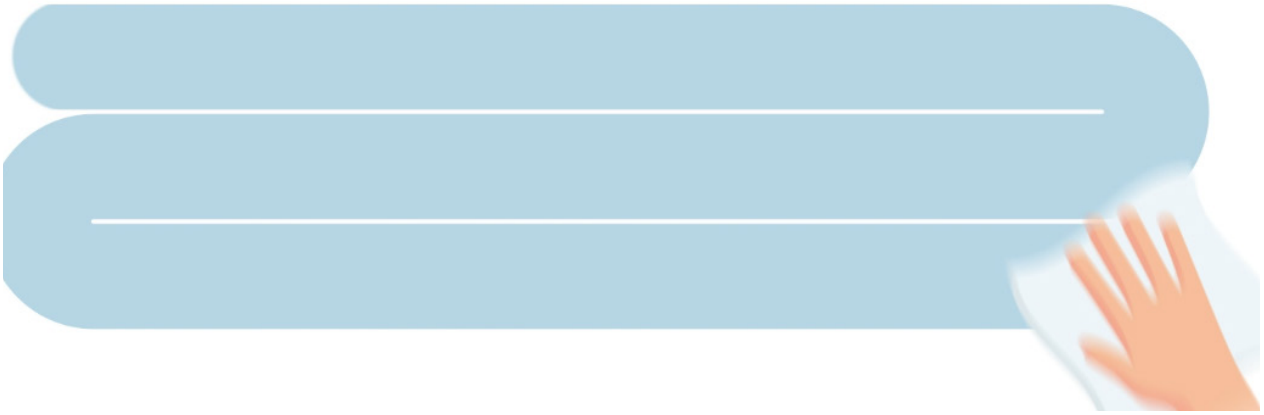
How to fold the mop/wipe



Wiping action

- Wipes are to be used as per the manufacturers' instructions
- Use a single wipe for each site; some sites might require multiple wipes (e.g., bed frame)
- Using the wipe flat on the surface after unfolding maximizes the area cleaned and reduces hand contact
- Clean surfaces should be wiped first, usually from top to bottom on vertical surfaces and back to front on horizontal ones
- Move in one direction from right to left or left to right consistently. Do not interchange. Use one wiper for each stroke
- Wipe in a single direction without retracing the already cleaned area; wipe a large open uniform surface in an S-shaped pattern
- Apply the 'one wipe; one site; one direction' principle
- When using a single cloth, disinfect it after each site or discard it and use a new one. Disposable wipes should be thrown away after each use or if they are clearly contaminated
- Pay due attention as the microorganisms may spread from one surface to another via gloves, clothing, scrubber-dryers, floor polishers, push type sweepers, vapor cleaners, vacuum cleaners, high pressure jet cleaners, and washers etc.
- Spray appropriate solutions for pest control (as per recommendations of the Indian Pest Control Association)

Figure 7.11 S-shape wiping action of flat surfaces[16]



Cleaning supplies and equipment[17]

The list of items that are advised for cleaning purposes is as follows.

- Mops
- Hand-held brush, brush with handle
- Floor squeezes
- Pails
- Cleaning cart
- Stepladder
- Folding wet floor sign
- Clothes for cleaning surfaces and equipment

Spill Management[17]

Spills of bodily fluids, including blood, are quite common in hospital environments and carry a very high risk of infection transmission. It's critical to have an efficient blood and bodily fluid spill management protocol in place to minimize this risk. These procedures must be routinely evaluated and modified as part of the overall hospital infection control program. The primary objective of the same is preventing harm to the patients, healthcare personnel, and the environment. These protocols help in reducing the chance of cross-contamination and infection transmission in healthcare setting.

- Blood-borne viruses can spread through blood and bodily fluid spills
- Spillages must be decontaminated immediately by staff trained to do it safely
- Responsibilities for the decontamination of blood and body fluid spillages should be clear within each area/care setting

Spill Management Protocol[17]

General recommendations for cleaning blood spills:

- Isolate the spill area
- Wear appropriate PPE for cleaning up the spill including gowns or aprons, boots, and protective shoe covers
- Heavy duty gloves should be worn during cleaning and disinfecting procedures
- PPE needs to be replaced if it is ripped or dirty
- Discard the broken glass in cardboard box with blue marking or blue bin (e.g., blood culture bottle, specimen vials etc.)
- Cover the area immediately with any absorbent material like tissue paper, old newspaper, old dusters and any organic waste should be removed and discarded in a yellow plastic bag
- Following the removal of organic matter, the area should be spread out with absorbent material, like paper or cloth. Then, adequate amount of freshly prepared 1% sodium hypochlorite solution should be poured over the spread in a circular motion from the periphery to the center, and it should be left undisturbed for 10-15 minutes. Thereafter, wipe everything off and discard the material in a yellow plastic bag
- Treated area should be cleaned with floor disinfectant and allowed to dry
- Remove and discard PPE
- Wash hands with soap and water
- Record and report the incident

Always use freshly prepared 1% sodium hypochlorite solution.

Table 7.8: Contents of spill kit[17]

Blood and body fluid spill kit contents:

- Caution board
- Gloves: 2 pairs
- Apron
- Mask
- Eye protection: goggles
- Shoe cover or plastic bag to cover the shoes
- Absorbent material like newspaper or blotting paper
- Mop
- Yellow Waste collection bag
- No need to keep hypochlorite in the kit

Cleaning equipment – bucket, mop, clothes, and hypochlorite solution can be obtained from housekeeping and must be washed and disinfected appropriately after use

All the spill kits must be readily available with all departments especially where risk of spill is more, like laboratory, sample collection room, wards etc

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Chapter 8

Disinfection and Sterilization Practices

Picture Credit: AIIMS, New Delhi

Disinfection and Sterilization Practices

Disinfection and Sterilisation practices play an essential role in preventing the transmission of infectious pathogens, thereby safeguarding patients and medical practitioners.[1]

Disinfection and Sterilisation practices play an essential role in preventing the transmission of infectious pathogens, thereby safeguarding patients and medical practitioners.[1]

- Disinfectants should be applied post-cleaning and must not be considered as alternatives to cleaning, except in alternatives where they are part of a combined detergent-disinfectant product.[2]
- Low-level disinfection typically suffices for environmental cleaning protocols; however, certain scenarios necessitate intermediate-level disinfection possessing sporicidal efficacy, such as in the case of *C. difficile*[2]

Sterilization

It is the practise of destroying or eliminating all types of microorganisms using physical or chemical means in health care facilities. The most prevalent sterilising agents include high-pressure steam, dry heat, EtO (Ethylene oxide) gas, hydrogen peroxide gas/ plasma, and liquid chemicals. Chemicals that eliminate all types of microbiological life are known as chemical sterilant. The germicides employed for shorter exposure periods can also be employed for high level disinfecting purpose.[3]

Disinfection vs Sterilization[1]

As per CDC guidelines Disinfection is *"the process of destroying all pathogenic microorganisms (refers to the action of antiseptics as well as disinfectants), whereas sterilization is the process of destroying all microorganisms, including spores."*

- Steam stands as the favored technique for sterilizing crucial medical and surgical instruments/items, provided they are not susceptible to damage from heat, pressure, or moisture.
- "Dry heat" can also be used for some items
- "Low temperature sterilizations technologies", e.g., plasma sterilisation using hydrogen peroxide are used for reprocessing medical devices and items that are heat sensitive

Figure 8.1 Cleaning, disinfection, and sterilization processes

		Sterilization
	Disinfection	
Cleaning		
Dirt and Soil	Microorganisms	Microorganisms and spores

The following cleaning and disinfecting materials are commonly used in healthcare settings (see Table 8.1): [4-7]

- Soap
- Alcohols: 60-90% ethyl or isopropyl alcohol/ denatured ethyl alcohol
- Iodophors
- Quaternary Ammonium Compounds ('QUATs')
- Chlorine and Chlorine Compounds
- Sodium di-chloro-iso-cyanurate (Na DCC)
- Calcium Hypochlorite
- Sodium Hypochlorite ('bleach')
- Phenolic

- Aldehydes (to be used only for environmental and/or equipment disinfection as per product contents)
- Hydrogen Peroxide (to be used only as an antiseptic)

Table 8.1: Properties of cleaning and disinfecting agents used in HCFs (Reproduced from WHO, MoHFW, Public Health Ontario)[5, 7, 8]

Product	Advantages	Disadvantages	Antimicrobial efficiency	Usage & Keypoints
Neutral Detergents	• Good material compatibility • Good for soil removal	• Some research demonstrates that enzymatic cleaning products are more effective than the neutral detergents in removing microorganisms from surfaces	• Reduces microbial load through chemical and mechanical action	• Critical role in removal of soil prior to disinfection
Alcohols (60-90% v/v)	• Rapidly bactericidal; non-toxic • Stable in closed containers • Low cost • Non-staining • No residue • Effective on clean equipment/ surfaces • Non-irritant	• Inactivated by organic matter • Evaporates quickly • Flammable – store in a cool well- ventilated area • Can damage/ corrode some surfaces, for e.g., rubber/plastic etc.	• Good activity against bacteria, myco-bacteria • Moderate activity against enveloped and non-enveloped viruses • No or insufficient activity against spores	• Can be used on external surfaces of some equipment • Non-critical equipment used for home healthcare • Disinfection achieved after 10 sec to 1 hour of contact
Iodophors	• Rapid action • Non-toxic	• Corrosive to metal unless combined with inhibitors • Inactivated by organic materials • May stain fabrics and synthetic materials		• Hard surfaces and equipment that does not touch mucous membranes (e.g., IV stands, wheelchairs, beds, call bells etc.) • Do not use antiseptic iodophors as disinfectant on hard surfaces
Hydrogen peroxide 3% (non-antiseptic formulations)	• Rapid action • Safe for the environment • Non-toxic	• Contraindicated for use on copper, zinc, brass, aluminium • Store in cool place, protect from light	• Active against a wide range of micro-organisms, including bacteria, yeasts, fungi, viruses, and spores	• Noncritical equipment used for home health care • Floors, walls, furnishings • Disinfection is achieved with a 3% solution after 30 minutes of contact

Product	Advantages	Disadvantages	Antimicrobial efficiency	Usage & Keypoints
Chlorine releasing agents (For example, sodium hypochlorite, bleach 0.5%-1% available chlorine or 5000-10,000ppm)	• Low cost. • Rapid action • Broad spectrum including spores • Relatively safe • Readily available	• Corrosive to metals • Inactivated by organic materials – for blood spills, blood must be removed prior to disinfection • Irritant/sensitizing agent - reported to cause respiratory irritation, skin irritation, and allergic reactions • One of the leading allergens affecting health care providers • Stains clothing • Not stable once made (shelf life is limited)	• Good activity against bacteria, mycobacteria, spores, enveloped and non-enveloped viruses	• Spill management; disinfection of countertops (not metal) and floors • Freshly prepared solution to be used • Use in well-ventilated areas • Store in closed containers away from heat and light to prevent deterioration
Hydrogen peroxide enhanced action formulation (HP-EAF) 0.5% (7% solution diluted 1:16)	• Safe for environment • Non-toxic • Rapid action • Available in wipes • Active in the presence of organic material • Excellent cleaning ability due to detergent properties	• Contraindicated for use on copper, brass, carbon tipped devices and anodised aluminium	• Active against a wide range of micro-organisms, including bacteria, yeasts, fungi, viruses, and spores	• Isolation room surfaces • Clinic and procedure room surfaces • Low level disinfection is achieved after 5 minutes of contact at 20˚C
Quaternary Ammonium Compounds ('QUATs')	• Good cleaning ability usually have detergent properties • Non- staining on surfaces	• Variable stability • Inactivated by organic material • Slight corrosive/ damaging to materials • Reported to cause respiratory irritation, skin irritation and allergic reactions • One of the leading allergens affecting health care providers	• Variable to moderate activity against bacteria • Less effective against Gram-negative bacteria • No activity or insufficient activity against mycobacteria and spores • Variable activity against enveloped and non-enveloped viruses	• Floors, walls and furnishings • Blood spills prior to disinfection • Not recommended by WHO

Product	Advantages	Disadvantages	Antimicrobial efficiency	Usage & Keypoints
Clear soluble phenolics (1-2%)	• Stable. • Not inactivated by organic material	• Slightly corrosive/ damaging • Irritant/sensitizing agent - reported to cause respiratory irritation, skin irritation and allergic reactions • One of the leading allergens affecting health care providers	• Good activity against bacteria • Moderate activity against Myco-bacteria and enveloped viruses. • No activity or insufficient activity against spores • Variable activity against non-enveloped viruses	• Floors, walls and Furnishings • Hard surfaces and equipment that does not touch mucous membranes (e.g., IV poles, wheelchairs, beds, call bells) • Do not use phenolics in nurseries • Not recommended by WHO

Fogging [6]

Routine fogging is NOT recommended and fogging may be carried out in the following situations only:

- Commissioning of new critical areas such as OTs and ICUs
- After annual maintenance in OTs and ICUs
- If microbiology surveillance reports and/ or clinical procedures carried out indicate a need

It is done using a non-toxic, environment friendly disinfectant for OTs should invite fogging surface disinfection. It is a complex formulation of stabilized in critical area Hydrogen Peroxide (11% w/v) with Silver Nitrate solution (0.01% w/v), (Silver nitrate stabilizes H^2O^2). It can be carried out in the following conditions:

- Air borne diseases like Tuberculosis, Influenza, Ebola, etc. (After patient's discharge/death in the facility)
- Any known fungal infection in the facility (e.g., Aspergillus)

Instructions to be followed for terminal disinfection.

- Wear suitable PPE
- Areas visibly contaminated should first be cleaned using a damp cloth with water or soap, followed by the application of a disinfectant-soaked cloth to clean the surface
- For disinfection make solution as per the manufacturer's instructions
- Pour reconstituted solution into a container
- Take a fresh cloth and immerse it into the solution, then wring it out
- Use the moistened cloth to clean all surfaces, including the undersides of medical equipment, operating tables, ICU beds, side lockers, lights, instrument tables, mattresses, walls, and other relevant areas
- Once the cloth becomes relatively dry, dip it once more into the solution, and wring it out to continue the aforementioned procedure until all surfaces are thoroughly cleaned.

Procedure of fogging[6]

- As per the room size and manufacturer's instructions make fogging solution and pour it into the tank of fogging machine

- Prior to commencing fogging, ensure that electronic equipment is covered with clean or sterile drapes
- Position the fogger at a minimum height of 2 feet above the floor surface, placing it in one corner of the room. Orient the nozzle head at a 45-degree angle, facing the diagonal corner, as depicted in Figure 8.2
- While using two foggers, position them in opposing directions

In case if the patient care/support area has a window air conditioner or split air conditioning arrangement:

- Switch on the air conditioning system (particularly for window or split AC units) for a duration of 10 minutes once fogging commences
- Set the timer on the fogging machine according to the amount of solution in the tank before activating the fogger
- Upon concluding the fogging procedure, which entails switching off the fogger, it is recommended to allow a duration of 45 minutes for the mist to dissipate and settle
- If you come across any damp areas, use a clean cloth to wipe them dry
- If the patient care/support area is equipped with central air conditioning, ensure to close the AC vent before commencing fogging
- The fogged area can be made accessible for use once the air conditioning system is turned on

Spaulding Classification[9]

The Spaulding Classification is a framework developed by Earle H. Spaulding in the 1960s for the disinfection and sterilization of medical and surgical devices.

The Spaulding Classification is used to stratify the infection transmission risk of medical devices based on the type of patient tissue they contact. This classification system then dictates the level of disinfection or sterilization required for that particular device.

It has been widely adopted as a fundamental guide for device disinfection and sterilization in healthcare settings, contributing significantly to infection control practices. This classification system is probably as valid today as it was in 1960s.

Figure 8.2 **Position of fogging machine in a room during terminal cleaning**

Table 8.2: Spaulding Classification[10]

Class	Meaning	Examples
Critical	A device that penetrates normally sterile tissue or comes into contact with the vascular system, or through which blood flows, must be sterile. Sterilization, defined as the complete destruction of all microbial life, is necessary for such devices	
Semi critical	A device that comes in contact with intact mucous membranes but does not typically penetrate sterile tissue requires at least high-level disinfection. This process entails eliminating all vegetative microorganisms, mycobacteria, small or non-lipid viruses, medium or lipid viruses, fungal spores, and certain bacterial spores.	
Non-critical	Devices that typically do not come into direct contact with the patient or only touch intact skin should undergo cleaning with low-level disinfection.	

The Spaulding Scheme, while valuable for infection control, faces challenges in its practical application. Its broad categorization can overlook the intricacies of reprocessing heat-sensitive equipment and inactivating certain infectious agents like prions. Additionally, variable guidelines on the optimal contact time for high-level disinfection across organizations complicate its uniform application. As medical practices and devices evolve, the Spaulding Scheme's relevance and effectiveness are continually tested, emphasizing the need for regular updates and refinements.[11]

Reprocessing of Reusable Medical Devices[6]

Reusable medical devices are devices that health care providers can reuse to diagnose and treat multiple patients for e.g., surgical instruments, endoscopes, laryngoscopes, etc. (Table no. 8.4)

Reusable medical equipment picks up dirt and germs after being used on patients. Reusable devices are subjected to "reprocessing," a thorough, multi-step procedure that involves cleaning, disinfecting, and sterilising them in order to eliminate any chance of infection from a contaminated device. An effort should be made to procure items that are heat and moisture resistant.

Table 8.3: Disinfection/Sterilization of commonly used equipment's in HCF[6, 11]

1.	Ampoules	• Wipe off the the neck with 70% alcohol before cutting it
2.	Flexible endoscopes	• Ensure all channels are flushed and brushed, if accessible, to eliminate any organic residue • Clean the external surfaces and accessories of devices using a soft cloth, sponge, or brush. After high-level disinfection, all channels must be rinsed with sterile water, followed by a rinse with 70% alcohol • Subsequently, air dry the channels with force. Hang the endoscope vertically in accordance with the manufacturer's instructions
3.	Rigid endoscopes	• As these instruments pass through normally sterile tissues, they must be subjected to sterilization. (Manufacturers' instruction should be followed stringently)
4.	Incubators (neonates)	• Surface should be washed with detergent and dried with sterile wipes
5.	Surgical instruments	• Contaminated surgical instruments must be washed in a hot water washer disinfector before sterilization. Heat sensitive instruments should be decontaminated and cleaned with chlorine releasing chemical, 2% glutaraldehyde, or 70% alcohol
6.	Sputum containers	• If non disposable, then it must be ensured that they are thoroughly cleaned followed by sterilization
7.	Oral thermometers	• Preferably, use individual thermometers, wipe with 70% alcohol and store dry. Avoid oral use if shared betweeen patients. For common use, wipe the thermometers and dip it in 70% alcohol. Store it dry after each use
8.	Stethoscopes	• Wipe the diaphragm with 70% alcohol once daily or when visibly soiled. In critical areas dedicated instruments should be used for each patient. If this is not possible, then clean with 70% alcohol after each use
9.	BP cuffs	• BP cuffs with synthetic covers should be cleaned with70% isopropyl alcohol in between patients. In critical areas, dedicated instruments should be used • Cuffs with cloth covers should be washed periodically or when visibly soiled
10.	Laryngoscopes	• Blade: After each use, clean with enzymatic/neutral detergent and water to remove any organic material. Disinfect with 70% isopropyl alcohol swab and store dry • Handle: Clean with a wet cloth and store dry
11.	Suction equipment	• Equipment: Clean regularly with a wet cloth • Bottles: Empty regularly and wash with detergents and hot water, and store dry • Tubing: It is advisable to use autoclavable tubing. Sterilize or disinfect the tubing every 24 hours • Wash the tubing with detergent and water, rinse thoroughly, and remove excess water • Disinfect the tubing using 2% glutaraldehyde. Ensure the tubing is completely submerged, and the lumen remains in contact with the disinfectant for 20-30 minutes • Afterward, remove it from the solution, rinse with sterile water, and allow it to dry • Store the tubing in a dry environment. If extension tubing is cleaned and decontaminated with glutaraldehyde or sterilized using appropriate methods, it can also be stored in dry linen

12.	Anaesthesia and ventilator circuits (including humidifiers,T-piece,etc.)	• Preferably disposable circuits should be used • To clean the tubing and remove any organic material, use a combination of detergent and water. Thoroughly rinse the tubing with water after cleaning • Submerge the tubing in a container or bucket filled with a 2% glutaraldehyde solution • Ensure that the disinfectant fills the lumen of the tubing and let it remain in contact for a minimum of 30 minutes. If sterilization is required, immerse the tubing for 8-10 hours • After the appropriate duration, remove the tubing from the bucket and rinse it with sterile water • Allow the tubing to dry completely and then store it in either sterile linen or sterile plastic bags, following the recommendations provided by the manufacturers
13.	Nebulizer	• Preferably single set should be used for individual patients and the set should be disinfected daily using the same procedure as that for ventilator circuits • Ensure that the chambers and tubing are absolutely dry
14.	Facemask, AMBU bags and reservoirs	• These should be disinfected after each use using same method as for ventilator circuits
15.	Oxygen hood	• Wash with soap and water, store dry
16.	Needle and syringes	• Use only disposables
17.	Body piercing needles and neurologic test needles	• While disposable, single-use items are preferred, there are situations where reusing these items may become necessary • In such instances, it's crucial to ensure thorough cleaning followed by proper sterilization to eliminate any organic material • This can be accomplished using either ethylene oxide or 2% glutaraldehyde with a contact period of 8-10 hours • Alternatively, if the items are heat resistant, autoclaving can be utilized as a sterilization method
18.	Probes of pulse oximeter and temperature probes	• Should be cleaned if visibly soiled and disinfected with 70% isopropyl alcohol
19.	Wall humidifiers snd Oxygen tubing	• Should be decontaminated and disinfected every 24 hours and stored dry (for ventilator tubing)

Central Sterile Supply Department (CSSD)

The Central Sterile Services Department (CSSD), also called Sterile Processing Department (SPD), or Central Supply Department (CSD), is an integrated place in hospitals and other health care facilities that performs sterilization and other actions on medical devices, equipment and consumables.[12] The purpose of CSSD is to supply all departments of a hospital (operation theatres, wards, out-patient, emergency services etc.) with complete, sterile instruments and items, equipment ready and available for immediate use in the treatment of patients.[13] In some healthcare facilities, within the OT complex instruments are sterilized in a unit called 'Theater Sterile Supply Unit' (TSSU), which are generally kept, cleaned, sterilized, and used in the operation theatres.

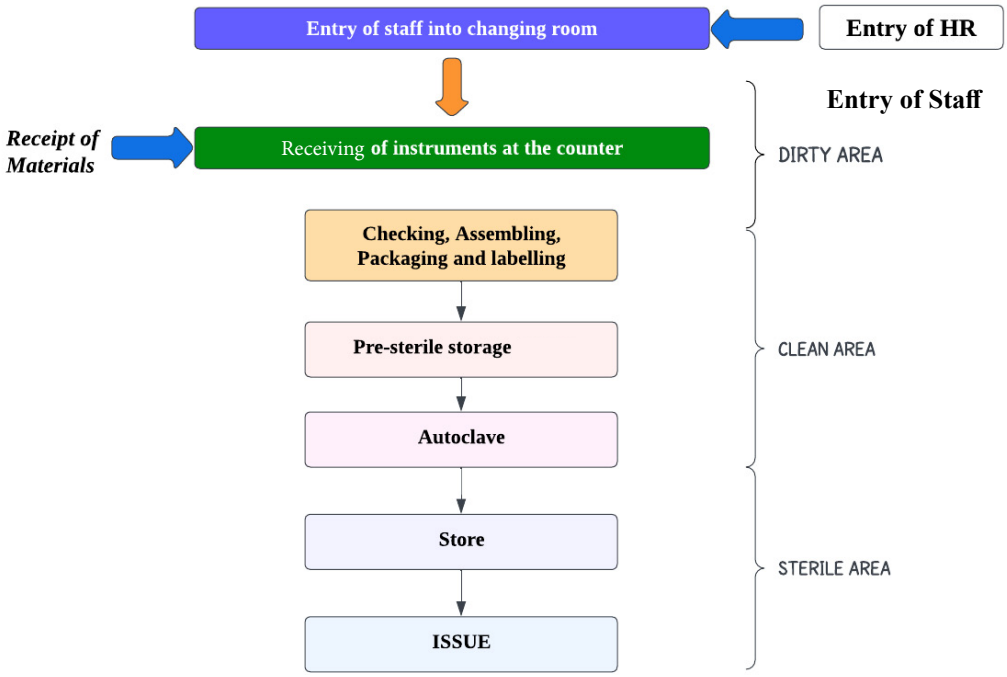
Process flow in the CSSD

The process flow within a Central Sterile Supply Department (CSSD) involves a sequence of standardized steps to ensure that all medical and surgical devices are adequately cleaned, sterilized, and ready for safe use on patients. (Figure 8.3)[14]

Layout of the CSSD should be divided into areas that are physically and environmentally separated with a clear unidirectional workflow into dirty, clean and sterile area[14]

Physical barriers, like walls or double-door (pass-through) washer-disinfectors, should separate the decontamination and packing areas. Similarly, double-door (pass-through) sterilizers should be in place between the packing and sterile storage zones. There should be no interchange of staff or devices unless explicitly required, such as returning improperly cleaned devices. The layout should facilitate one-way movement of staff and devices from contaminated to clean areas to reduce bioburden and particulate contamination.[14]

Figure 8.3 Categorisation of various areas and process flow in CSSD[14]



Various areas in CSSD are[14]:

- Entrance and corridors (public areas)
- Changing areas for staff to don PPE prior to entering work areas
- Dirty area for receiving of used medical devices (dirty area)
- Inspection, assembly and packing (IAP) (clean)
- Sterilization area (sterilizers)
- Sterile store (cooling and short-term storage)
- Administration and staff rest and changing areas (essential to be away from work areas)
- Storage for devices, chemicals and packaging stores (raw material and products)

Sterilization in small units[14]

In dental clinics and Primary Health Centers (PHCs), the sterilization area is usually a smaller, designated space where device reprocessing occurs, isolated from clients/patients/ residents and clean area. The workflow remains consistent, and efforts are made to delineate between dirty and clean areas whenever feasible.

CSSD dress code[14]

All employees working in Central Sterile Services Department (CSSD) should be provided with uniforms laundered on-site (not taken home for washing). They should change into these uniforms upon arrival at work and remove them before leaving.

Table 8.4: Indications for the use of PPE in the CSSD[14]

PPE indication	Gloves	Face cover/visors	Head gear	Aprons/ gowns	Closed shoes
Decontamination area • Handling used medical devices • Removal and disposal of sharps • Manual cleaning	Domestic gloves (heavy duty); long; disposable or tear-resistant if reused. If available use nitrile gloves	Cover mucous membranes and eyes • Mask with integrated visor • Full visor • Face mask with goggles	Yes	Yes	Yes
IAP • Inspection after cleaning • Assembly • Packaging	Not indicated	Not indicated	Yes	Optional	Yes
Sterilization • Loading • Emptying sterilizer	Heavy duty Heat-resistant gloves	Not indicated	Yes	No	Yes
Sterile stores • Loading shelves • Taking inventory • Documentation	Not indicated	Not indicated	Optional	No	Yes
Transportation • Delivering sterile pack	Not indicated	Not indicated	Optional	No	Yes
• Returning used medical devices	Yes - domestic gloves (heavy duty)	Only when handling open wet trays	--	Yes	Yes

Various methods for sterilization

Steam under pressure (moist heat)[15]

This method is the most effective and dependable approach to attain sterility of instruments, linens, and equipment. Various types of steam under pressure sterilizers, also known as autoclaves, are available.

- Gravity displacement sterilizers (both jacketed and non-jacketed) operate by admitting steam at the top or sides of the sterilizing chamber. Due to the lighter weight of steam compared to air, it displaces air downwards through the drain vent at the bottom of the chamber. These autoclaves are predominantly employed for processing laboratory media, water, pharmaceutical products, regulated medical waste, and nonporous articles that come into direct contact with steam on their surfaces

- Self-contained (benchtop) sterilizers are ideal for office-based practices as they can handle small quantities or relatively simple items. These sterilizers are not suitable for wrapped items, so items must be used immediately after being removed. Variations exist among models, with features such as drying stages, capacity to accommodate packaged and unwrapped items, and systems for monitoring temperature, pressure, and holding time differing between models

- Pre-vacuum (porous load) sterilizers operate similarly to gravity displacement sterilizers but are equipped with a vacuum pump or ejector to facilitate air removal from the sterilizing chamber and load before admitting steam. The inclusion of a vacuum pump ensures rapid steam penetration, particularly into porous loads. While these sterilizers are not suitable for liquid sterilization, they are optimized for sterilizing clean instruments, gowns, drapes, towel, and other dry materials essential for surgery. Secondary and tertiary healthcare facilities are advised to utilize pre-vacuum sterilization in Central Sterile Services Department (CSSD) and Theatre Sterile Supply Unit (TSSU)

Dry heat sterilization[16]

Dry heat sterilization employs hot air to eliminate pathogens through oxidation. This method is suitable only for materials that may be damaged by moist heat or are impermeable to it, such as powders, petroleum products, and sharp instruments. However, dry heat sterilizers have limited efficacy due to challenges in maintaining uniform temperature throughout the load. Additionally, the prolonged exposure to high temperatures required for sterility makes this method less favorable for many applications. It is imperative to adhere to manufacturers' instructions and refrain from opening the sterilizer door during the sterilization cycle.

Ethylene oxide (EtO)[17]

Ethylene oxide (EtO) gas is an effective sterilant for medical instruments and equipment made from thermolabile materials or those incorporating electronic components. The sterilization cycle duration is influenced by variables such as ambient temperature, relative humidity, and the concentration of EtO gas. Successful sterilization necessitates the diffusion of the gas through the packaging to contact all surfaces of the item requiring decontamination. The requisite time for a complete sterilization cycle ranges from 12 to over 24 hours. Given the toxic properties of EtO, its application in healthcare environments is regulated under stringent safety protocols to mitigate occupational exposure risks. Adherence to manufacturer-provided guidelines for packaging, execution of the sterilization cycle, process validation, and post-sterilization aeration is imperative.

Automated chemical (low temperature) systems[18]

Hydrogen peroxide sterilization, conducted within a fully automated operational cycle, is designed to achieve sterilization under conditions of low temperature and minimal moisture. The duration of this sterilization process varies between 45 to 80 minutes, based on the specific make and model of the sterilization equipment utilized. This method

necessitates the use of packaging materials that are made of non-woven or non-cellulose polypropylene wraps to ensure compatibility with the sterilization medium.

In a parallel methodology, peracetic acid sterilization operates at low temperatures and utilizes a 0.2% peracetic acid solution. This chemical sterilant is used within an environmentally controlled and hermetically sealed chamber that is part of a fully automated processing system. The process utilizes the moist sterilization environment to achieve effective sterilization within a short span of 25 to 30 minutes.

Irradiation[19, 20]

Gamma irradiation employs ionizing radiation, specifically gamma rays often sourced from Cobalt-60, as an effective sterilization technique extensively used in sterilizing medical devices and certain drugs. This method destroys the DNA of microorganisms, ensuring they are deactivated and the items are sterilized. Despite its effectiveness, the use of gamma radiation is mainly limited to specialized commercial irradiation facilities due to various operational, safety, and regulatory challenges, making it less accessible for in-house use within healthcare institutions. Only those medical instruments and equipment that have completed the full sterilization cycle can be deemed sterile. Therefore, gamma irradiation serves as a crucial sterilization mechanism within the medical and pharmaceutical sectors, yet its deployment is restricted to facilities that can meet the stringent requirements for its safe and effective use.

Boiling [19]

It is advised against using boiling as a method for sterilizing medical devices for reuse, as it cannot assure sterility. Nonetheless, in contexts where resources are limited and steam sterilization cannot be implemented, it is recommended that these devices first be meticulously cleaned and then sterilized by being placed in a pressure cooker for a duration of 30 minutes.

Packaging [19]

For items to be deemed sterile, they must be properly wrapped or packaged. The materials suitable for packaging encompass:

- Linen material: Cost effective and reusable. It is most commonly used packing material in healthcare facilities
- Paper: Effective in preventing contamination when undamaged, paper preserves sterility over extended periods. It can serve as a sterile barrier and may also be utilized to encase used instruments post-procedure
- Non-woven disposable fabrics
- Containers: These are suitable solely for materials designated for one-time therapeutic procedure of an individual patient

It is crucial for the end user to verify the package's integrity before use.

Quality control for sterilization[14, 21]

Parameters for quality control in the sterilization process, which serve as a checklist for the Sterilization Department, encompass the load number, contents of the load, records of temperature and time exposure, along with physical/chemical and biological testing. Additionally, routine engineering maintenance of the sterilization equipment is essential and must be thoroughly documented.

Various indicators employed in sterilization.

Multiple markers, including physical, chemical, and biological, are utilized to monitor and confirm the success of the sterilization process. These markers provide various degrees of assurance that sterilization conditions were met during the process.

- **Physical Indicators:** Physical indicators for sterilization primarily involve the direct measurement of critical sterilization parameters like temperature, pressure, and time. These are critical components

in various sterilization methods, including steam and dry heat sterilization. Ensuring that the correct temperature is reached and maintained for a specific duration is essential, for which temperature gauges and thermocouples are often used to monitor the temperature inside the sterilization chamber.

Pressure measurement is also crucial, particularly in steam and dry heat sterilization processes because a specific pressure level, usually above atmospheric pressure, is required to achieve the necessary sterilization temperature. Pressure gauges are used to measure the pressure inside the sterilization chamber. Furthermore, time monitoring is another key aspect of the sterilization process. The duration of the sterilization process can be monitored using simple timing devices. It's important to note that the required exposure time will depend on the type of sterilization process and the nature of the items being sterilized[22-27]

- **Chemical indicators:** Chemical indicators (CIs) are an integral part of the sterilization process, designed to respond to one or more of the physical conditions within the sterilizing chamber. The purpose of CIs is to give a visible change, usually a change in colour, in response to exposure to predetermined critical sterilization parameters, such as temperature, time, and the presence of steam. CIs are generally affixed to or incorporated into packaging materials or used inside sterilization packs. They are not intended to prove sterilization but to indicate that the sterilizing agent has penetrated to the position of the indicator and directly contacted it for a specified temperature and time. Chemical indicators are classified into six types (Type 1 to Type 6) depending on their intended use[21, 27]

- **Biological indicators:** Biological indicators (BIs) are test systems containing viable microorganisms providing a defined resistance to a specified sterilization process. They provide a direct measure

Table 8.5: Various methods of sterilization, sterilization condition, and uses.[28]

Method of Sterilization	Sterilization Conditions	Uses
Autoclave	121° C x 30 min OR 132° C x 15 min/4min Temperature and time vary with type of load and type of sterilization cycle (Gravity displacement/ pre vacuum) selected	Surgical instruments, implants, rubber catheters, dressing drums/trays/sets, metal endoscopes, endotracheal tubes airway etc.
Dry heat (Hot air oven)	170° C x 60 minutes 160° C x 120 minutes 150° C x 150 minutes	Sterilization of materials that might be damaged by moist heat or that are impenetrable to moist heat (e.g., powders, petroleum products, sharp instruments)
Ethylene oxide (ETO)	100% or mixtures at various concentrations with inert gases	Sterilize critical items (and sometimes semi critical items) that are moisture or heat sensitive and cannot be sterilized by steam sterilization
Plasma sterilization	Hydrogen peroxide	Sterilization of materials and devices that cannot tolerate high temperatures and humidity, such as some plastics, electrical devices, corrosion-susceptible metal alloys etc.
Irradiation	Cobalt 60 Gamma rays	Sterilization of medical products (e.g., tissue for transplantation, pharmaceuticals, medical devices) or disposable prepacked items at industrial level

of the lethality of the process and are considered the most valid method for monitoring the sterilization process because they measure the process's ability to kill microorganisms, not merely conditions leading to sterilization. BIs typically consist of a known quantity of a specific type of microorganism, usually bacterial spores, placed on a suitable carrier and packaged in a way to maintain the integrity and viability of the inoculated carrier. These spores were chosen because they are more resistant to the sterilization process than most other microorganisms. After sterilization, the BI is cultured to test for viability, with a positive result indicating sterilization failure. [21, 27]

The species of bacterial spores used for steam and vaporized hydrogen peroxide sterilization is Geobacillus Stearothermophilus for Ethylene oxide and dry heat sterilization is Bacillus Atrophaeus.

The presence of living spores after the sterilization process indicates that the process was not sufficient to achieve sterilization. If no growth is observed, it's assumed that the sterilization process was effective.

Using biological indicators in combination with physical and chemical indicators can provide a comprehensive validation approach that confirms both the correct execution of the sterilization process (physical and chemical indicators) and its effectiveness in killing microorganisms (biological indicators)

Importance of CSSD during a Public Health Emeargency

The CSSD plays a crucial role during a public health emergency, such as COVID-19, in ensuring the continuous supply of sterile medical items/equipment to healthcare facilities while maintaining infection control measures. The CSSD's primary function is to sterilize and distribute medical and surgical devices used in patient care, a role that becomes even more critical during public health emergencies

- **Infection Control**: During a public health emergency, when the threat of disease transmission is highest, the importance of the Central Sterile Services Department (CSSD) in sterilizing medical and surgical

Table 8.6: Various chemical indicators for quality control for sterilization process[21]

Type of chemical indicators	Implication	Application
Type 1 (Process Indicators)	Used for distinguishing between processed and unprocessed items	Intended for use with each package or item to demonstrate that the unit has been directly exposed to the sterilization process
Type 2 (Specific Test Indicators)	Designed for use in specific tests, such as the Bowie-Dick test	Used to detect air leaks and inadequate air removal in pre-vacuum steam sterilizers
Type 3 (Single-Variable Indicators)	Respond to only one critical parameter	Intended to indicate exposure to a sterilization cycle at a stated value for the chosen parameter
Type 4 (Multi-Variable Indicators)	Respond to two or more critical parameters	Indicate exposure to a sterilization cycle at the stated values for the chosen parameters
Type 5 (Integrating Indicators)	Respond to all critical parameters over a specified range of sterilization cycles.	Intended to indicate whether the process requirements for a specified sterilization process have been met
Type 6 (Emulating Indicators)	Respond to all critical process parameters for a specified sterilization cycle (Cycle verification indicators)	Designed to react to all critical parameters of specified sterilization cycles

equipment becomes paramount to avoid cross-contamination and infections associated with healthcare. This involves rigorous compliance with sterilization procedures, encompassing the correct application of disinfectants and sterilants, to mitigate the dissemination of infectious diseases

- **Increased Demand for sterile supplies:** During a public health emergency, the demand for sterile supplies in healthcare facilities increases due to the influx of patients. CSSDs play a key role in meeting this demand, ensuring a sufficient supply of sterilized equipment, thereby enabling healthcare providers to deliver necessary patient care

- **Emergency Preparedness:** CSSDs are essential in emergency preparedness. They must have contingency plans to accommodate increases in capacity and changes in procedures. During a public health emergency, these plans might include extending operation hours, training additional staff, or augmenting sterilization capacity

- **Protection of CSSD Staff:** The personnel of the Central Sterile Services Department (CSSD) are essential and critical to the functioning of healthcare services. Ensuring their protection from potential infection during a public health crisis is crucial for the uninterrupted provision of services. Measures to protect these workers should include the provision of suitable personal protective equipment (PPE), comprehensive training, access to vaccinations (when available), and support for stress management

- **Innovation and Adaptation:** In the face of a public health crisis, Central Sterile Services Departments (CSSDs) might be required to quickly innovate and adjust to evolving circumstances, including sterilizing novel types of equipment or finding solutions to circumvent shortages of supplies. An instance of this was observed during the COVID-19 outbreak, where CSSDs took part in sterilizing N95 respirators for reuse in response to scarcities in personal protective equipment (PPE)

To sum up, the Central Sterile Services Department (CSSD) plays a pivotal role in healthcare environments, a significance that is magnified during public health crises. The department's commitment to stringent infection prevention measures, providing a steady supply of sterile medical materials, and their ability to adapt to unprecedented challenges are vital for reducing the spread of infectious diseases. The necessity for an efficient response to pandemics further emphasizes the importance of thorough CSSD preparation, compliance with established sterilization standards, and ensuring the safety of its staff. The performance of the CSSD under these conditions has a profound and direct influence on the overall ability of the healthcare system to offer secure and competent care to patients in the midst of a pandemic. Insights gained from experiences such as the COVID-19 pandemic should guide future strategies and preparedness initiatives, ensuring that CSSDs are fully equipped to fulfill their essential role in any emergency scenario.

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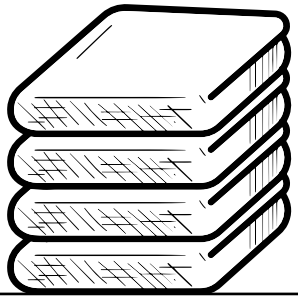
Chapter 9

Linen Management

Picture Credit: AIIMS, New Delhi

Linen Management



- In healthcare settings, linens encompass a broad range of items used by patients and staff. These include bed linens (sheets, blankets), towels, and patient garments (clothing, gowns). Additionally, healthcare workers utilize scrubs, surgical gowns, and drapes during procedures to maintain aseptic technique
- Textiles and fabrics used in healthcare settings can become heavily soiled with various bodily fluids and waste, including urine, stool, blood, skin, vomit, and other tissues and fluids. Research suggests that such heavily contaminated textiles can harbor significant bacterial loads, potentially reaching millions (10^6 - 10^8 colony-forming units) per 100 square centimeters of fabric[1]
- Soiled or contaminated linens in healthcare facilities can harbor various pathogens, posing a potential infection risk to vulnerable patients. These pathogens may include bacteria like Salmonella spp. and Bacillus cereus, viruses like Hepatitis B virus (HBV), fungi like Microsporum canis, and even ectoparasites like scabies. The transmission of these pathogens from contaminated textiles to healthcare workers is likely to occur through[1]
  - Direct contact or
  - Contaminated lint aerosols produced during the sorting and handling of contaminated textiles

Therefore, linen contaminated with infectious material poses a potential transmission risk. To mitigate this risk, healthcare personnel must adhere to strict protocols when handling soiled linen[2]

To minimize the risk of pathogen transmission, all soiled linen must undergo thorough laundering at appropriate temperatures that effectively eliminate microorganisms. Failure to achieve this has resulted in outbreaks of infection, notably with spore-forming bacteria such as *Bacillus cereus*. Micro-organisms that remain after washing are usually destroyed by tumble drying and ironing[2]

Figure 9.1 **Steps of linen movement in a healthcare facility[3]**

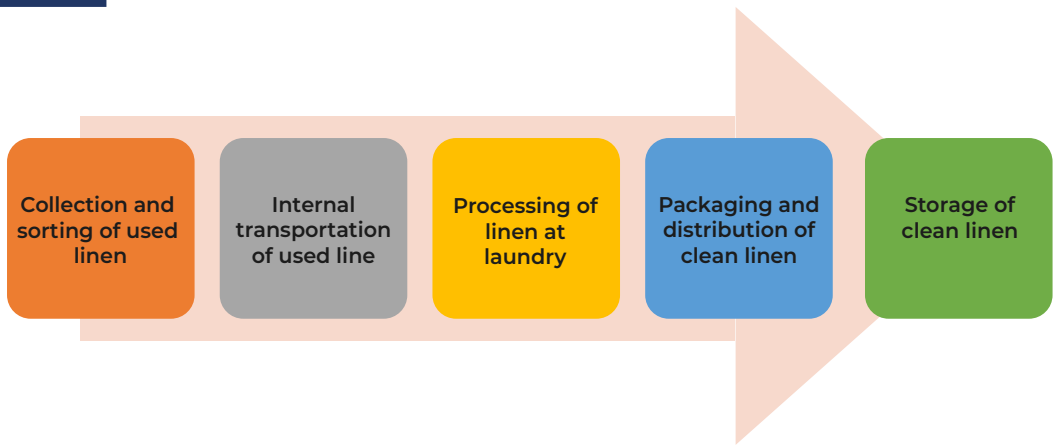


Table 9.1: Classification of linen[4]:

A	Clean Linen	• Linen items that are new, (processed linen) or are otherwise clean linen that have not yet been used
B	Used linen	• Used linen describes bed linen, towels and other items, which have been used by person receiving care • Not contaminated by blood and body fluids • Although used linen may look clean it can still contain large number of micro-organisms and skin scales • Used linen can include heat labile items
C	Infectious linen	• Linen from Patients with Known or Suspected Infections: This includes linens used by patients diagnosed with or suspected of having contagious diseases • Linen Contaminated with High-Risk Pathogens: This category encompasses linens potentially exposed to multidrug-resistant organisms (MDROs) like MRSA, VRE, or other highly infectious diseases such as HIV, HAV, HBV, and HCV • Linen from High-Risk Patient Groups: This includes linens used by patients with infections transmissible through low infectious doses, such as E. coli O157 or shigellosis • Linen Infested with Pests: This category refers to linens potentially contaminated with lice, fleas, or other pests requiring specific protocols for handling and disinfection • Linen Soiled with Bodily Fluids: This includes linens soiled with blood, pus, vomit, or other bodily fluids. Additionally, staff uniforms with blood or bodily fluid contamination, including surgical scrubs, fall under this category
D	Heat labile linen	• Linen that may shrink or be stretched by washing temperatures above 40˚C. It usually can't withstand industrial laundering processes
E	For Category 4 Pathogens	• Linen potentially contaminated with high-risk pathogens, such as anthrax, viral hemorrhagic fevers, or bioterrorism agents, should be bagged in designated yellow clinical waste bags for incineration • Linen from patients with suspected or confirmed Category 4 infections should not be returned to the laundry. This type of infectious linen should be disposed off as Category A waste and incinerated according to standard protocols • The laundry department must be informed whenever linen items are designated for incineration

Segregation of linen in healthcare settings

In healthcare facilities, linen is segregated into distinct categories. This rigorous process serves several crucial purposes. First, it prevents the cross-contamination by ensuring that clean and soiled linen never come into contact. Second, it safeguards both patients and staff from exposure to infectious agents that may be present on soiled linen. Finally, it guarantees that heat-labile linens undergo proper disinfection processes.

Immediate segregation of infectious linen at the point of use, rather than at the laundry facility, is an essential practice for infection control.

Laundry Bag Colour Coded System [2, 5, 6]

Used linen should be placed directly into a laundry bin beside the bed/point of use. Used linen should never be carried in arms, thrown on floors etc.

Colour coded systems can be helpful for support staff to segregate used *linen from infectious linen.*

- Clear/white: Used Linen
- Red/ Alginate bags: Infectious linen
- Blue: Heat labile

Linen contaminated with heavy soiling or infectious materials must be placed in a designated red, water-soluble bag at the point of use. This red bag should then be secured within a white, non-soluble plastic bag for further handling and disposal.

Table 9.2: Detailed Process of Linen Management[3]

Collection and sorting of used linen	• The place for sorting of used linen should be away from any patient care area • The space should be well lit and ventilated • Soiled linen should be handled as little as possible • Implement appropriate personal protective equipment (PPE) when handling used linens. • Store soiled and dry linen separately to prevent cross-contamination • Minimize agitation of contaminated textiles and fabrics to avoid dispersing infectious particles into the air • Refrain from sorting or pre-rinsing soiled laundry in patient care areas • Use leak-proof containers for linen contaminated with blood or bodily fluids • Clearly identify soiled linen bags or containers using labels, color coding, or alternative communication methods • Count of the different types of linen should be maintained during sorting so that there is no need to handle the same for counting again • Provision should be made to store the heavily soiled linen separately from those that are not heavily soiled • Collection of used linen should be done at such times so as to avoid public rush hours • Ensure that laundry bags are closed before transporting
Internal transportation of used linen	• Appropriate personal protective equipment may be used by the hospital worker involved in transportation of the used linen • An adequately sized laundry trolley should be available for the same • Carts and trolleys shouldn't be overloaded with worn, dirty, or wet linen • The person transporting the used linen on the trolleys should use a designated path, ideally via less busy areas of the hospital • If they must utilise busy areas or routes, they should make a loud announcement so that people may step aside and make room for the trolleys • The speed at which the carts are pulled should be managed to prevent any collisions with the hospital's side walls or other structures
Processing of the linen at laundry	• When used linen is brought to the area of laundering, it should be received from a route that is not used for carrying clean linen • All linen items should be thoroughly washed before reuse • Decontamination of linen prior to washing is not necessary except for soiled linen of HIV and HBV patients, otherwise the fabric deteriorates early • Appropriate personal protective measures should be adopted by workers during washing and drying (such as plastic/ rubber apron) • Soiled linen should be washed separately from non-soiled linen • Heavily soiled may be pre-soaked in soap, water and bleach

Shading needs to be done	• Washing linen at 70-80 degrees C for over 20 minutes with a detergent is an effective method to clean and reduce bacterial count • Washing may be repeated if the linen appears unclean • Clean linen should be completely dried after washing • After total drying, they should be checked for holes, thread bare areas and repaired accordingly • Clean and dry linen should be calendared as required and packed for distribution • Linen likely to go for sterilization need not be calendared as steam penetrability is reduced after ironing linen
Packaging and distribution of clean linen	• Storing Clean Linen » Keep clean linen in clean, closed storage areas » Wash hands before handling clean linen » Use physical barriers to separate folding and storage rooms from soiled areas » Keep shelves clean » Handle stored linen as little as possible » Area of storage should be free from moisture and dust • Transporting and Distribution of Clean Linen » Clean and soiled linen should be transported in separate carts/trolleys » They should be labelled to avoid confusion » Carts or trolleys should be washed according to schedule » Clean linen must be wrapped or covered when transported to avoid contamination
Storage of clean linen	• Protect clean linen until it is distributed for use • Do not leave extra linen in patients' rooms • Handle clean linen as little as possible • Avoid shaking clean linen. It may release dust and lint into the room • Clean soiled mattresses before putting clean linen on them

Recommended PPE for personnel processing linen[3]

Gloves (preferably household heavy duty utility gloves) and closed shoes that protect feet from dropped items (sharps) and spilled blood and body fluids, should be used when:

- Handling disinfectant solutions
- Collecting and handling soiled linen
- Transporting soiled linen
- Sorting soiled linen
- Hand washing soiled linen
- Loading automatic washers

Plastic or rubber apron and protective eyewear should be worn when

- Sorting soiled linen
- Hand washing soiled linen
- Loading automatic washers

Infection prevention measures for laundry workers[3]:

1. Use of PPE such as gloves, plastic/rubber aprons, gowns, and facemasks, and gum boots should be practised as a protocol
2. Workers should be immunized against tetanus and Hepatitis B
3. Protocol should be established for workup and treatment of the workers sustaining needle stick injury while processing linen
4. Regular training and instructions to the workers regarding the safe handling of linen

Quality check on laundering process[3]

1. Under sterile conditions, cut out a 10 cm X 10 cm area of a laundered /drycleaned fabric
2. With the sterile forceps, place it on a sterile culture plate for 15-20 minutes
3. Remove the cloth using sterile forceps and transport the plate to the Microbiology lab
4. The plate is to be incubated at 37° C for 24 hrs, and observed for bacterial growth
5. If the numbers of colonies are ≥ 20 CFU it will be considered unsatisfactory process

Other important measures:[3]

1. Laundry floors and work areas should have a regular cleaning schedule using a Hospital approved disinfectant
2. Areas should be vacuumed to remove lint
3. Wet-vacuumed pick-ups should be used for terminal cleaning
4. Casual visitors should not be allowed inside the laundry

The effectiveness of the laundering process depends on many factors, including[7]

- Time and temperature
- Mechanical action
- Water quality (pH, hardness)
- Volume of the load
- Extent of soiling
- Model/availability of commercial washers and dryers
- Always use and maintain laundry equipment according to the manufacturer's instructions

Best practices for laundering soiled linen[7]

- Follow instructions from the washer/dryer manufacturer
- Use hot water (70–80°C X 10 min) [158–176°F] and an approved laundry detergent
    - Disinfectant is generally not needed when soiling is at low levels
    - Use disinfectant on a case-to-case basis, depending on the origin of the soiled linen (e.g., linens from an area on contact precautions)
- Dry linen completely in a commercial dryer

Best practices for management of clean linen[7]

- Sort, package, transport, and store clean linens in a manner that prevents the risk of contamination by dust, debris, soiled linens or other soiled items
- Each floor/ward should have a designated room for sorting and storing clean linens
- Transport clean linen to patient care areas on designated carts or within designated containers that are regularly (e.g., at least once daily) cleaned with a neutral detergent and warm water solution

Manual reprocessing steps[7]

If laundry services with hot water are not available, reprocess soiled linen manually according to the following:

1. Immerse in detergent solution and use mechanical action (e.g., scrubbing) to remove soil
2. Disinfect by using one of these methods:
    - Immersing the linen in boiling water or
    - Immersing the linen in disinfectant solution for the required contact time and rinsing with clean water to remove residue
3. Allowing to fully dry, ideally in the sun

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Chapter 10

Transmission Based Precautions

Picture Credit: AIIMS, New Delhi

Transmission Based Precautions

Transmission-Based Precautions, employed alongside Standard Precautions, are essential for patients potentially infected or colonized with specific pathogens requiring additional interventions to stop the spread of infections. These precautions are crucial for individuals known or suspected to be carriers of pathogens that are highly transmissible or hold epidemiological significance, particularly when Standard Precautions may not suffice in preventing infection transmission.[1, 2]

Transmission-based precautions should be implemented during the care of:

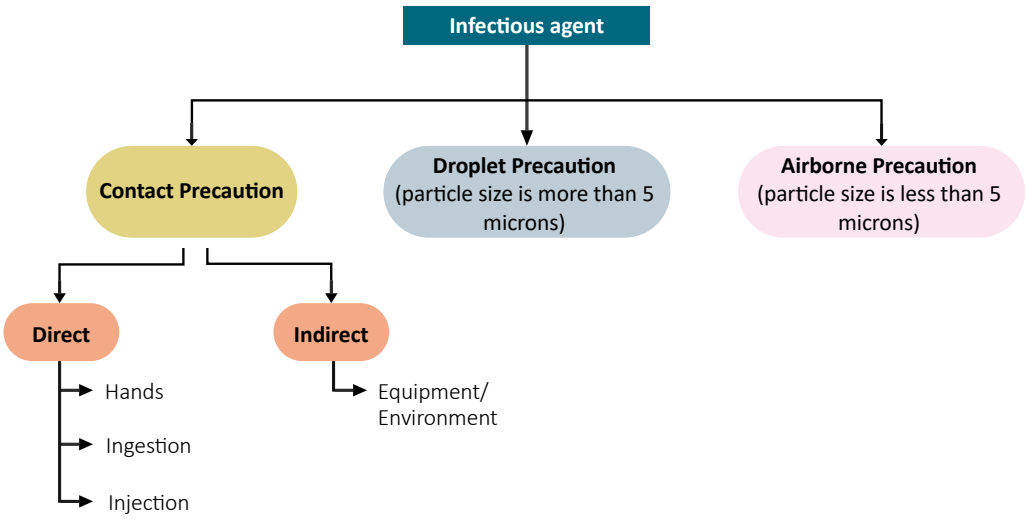
- Patients diagnosed with infection
- Patients harboring an infectious microorganism
- Asymptomatic patients under investigation for harboring an infectious microorganism[3]

Transmission based precautions are categorized by the route of transmission of infectious agents (some infectious agents can be transmitted by more than one route).[4]

Transmission-based precautions are classified into categorised according to the mode of transmission of infectious agents.

1. Contact precautions
2. Droplet precautions
3. Airborne precautions

Figure 10.1 **Transmission based precautions- categorisation[4]**



The Three Categories of Transmission-Based Precautions Necessitate the Implementation of Following Measures:

- Source control
- Hand hygiene
- Patient placement and accommodation
- Patient flow/transport
- Personal protective equipment
- Cleaning and disinfectiing equipment used in non-critical patient care
- Cleaning of the patient environment
- Linen, waste, and reusable dishes and eating utensils
- Education of patients, families and visitors
- Duration of precautions
- Handling of deceased bodies

Contact Precautions

- When combined with Standard Precautions, contact precautions aim to minimize the spread of microorganisms through direct and/or indirect contact. Illnesses that can be transmitted through this route are those involving colonization or infection with multi-antibiotic resistant organisms, enteric infections, and skin infections.

Source Control

This entails the prompt identification of the patient with a communicable disease followed by spatial separation from others[6, 7]

- A point of care risk assessment (PCRA) as per routine practice should be done to determine if contact precautions are required
- Separate entrances (during community outbreaks) for patients symptomatic with respiratory infections[7]
- A separate triage/ area of rapid assessment should be created

Hand hygiene

Perform hand hygiene as per the WHO hand hygiene guidelines. Please refer chapter 2 for details.

Cohorting Patients on Contact Precautions[8, 9]

- Patients infected with the same organism can be placed together in a single room (cohorting) to limit the spread of infection. However, to ensure effective cohorting, several additional measures are necessary:
  - **Keep patient notes and charts outside the room:** This minimizes the risk of contamination between patients and healthcare providers
  - **Hand hygiene after exiting the room and before touching charts:** This reduces the possibility of transferring pathogens between patients
  - **Clear signage on rooms:** Clear signage alerts staff of the precautions required when entering the room
- While cohorting can be an effective strategy, there are situations where it may not be suitable. Here are some key considerations: [10]
  - **High-Risk Patients:** Avoid placing patients on Contact Precautions with those at high risk for complications, such as immunocompromised individuals or those with open wounds
  - **Patients with Increased Transmission Risk:** Separate patients with conditions that heighten transmission risk, like indwelling devices or diarrhea, from others. If a dedicated commode isn't available, implement thorough disinfection procedures
  - **Physical Separation:** When possible, use privacy curtains or maintain a minimum distance (ideally 2 meters) between patients to minimize contact
  - **Visitor Precautions:** Ensure family members and visitors understand and adhere to necessary precautions when interacting with patients

Safe patient transport practices[8]

- **Minimizing Patient Transport**
  Patient transport should be limited to essential procedures only, such as diagnostic tests or treatments unavailable in the patient's room. This reduces the risk of complications and ensures efficient use of staff time

- **Transport Precautions**
  When transferring patients within or between facilities, several safety measures are crucial:

  - **Wound Protection:** Ensure all wounds are properly covered with appropriate dressings before transport
  - **Doffing PPE:** Prior to transporting a patient, healthcare providers must remove and dispose off used personal protective equipment (PPE) and perform hand hygiene
  - **Donning PPE for Transport:** Healthcare providers should wear fresh gloves and gowns for direct contact with the patient during transport

Personal Protective Equipment[8]

- Personal protective equipment (PPE) should be readily available outside the patient's room, cubicle, or anteroom (if available). Always perform hand hygiene before donning PPE

Cleaning and disinfection of noncritical equipment used in patient care[8, 10, 11]

- **Prioritize Disposable Items:** Whenever possible, use disposable patient care equipment to minimize the risk of transmission between patients

- **Minimize Clutter:** Limit the number of supplies and personal belongings brought into the patient's room to reduce surfaces requiring cleaning and disinfection

- **Dedicated Equipment for Single Patients:** Assign reusable equipment, like blood pressure cuffs, commodes, or thermometers, to a single patient for the duration of their stay

- **Cleaning and Disinfection of Reusable Equipment:** Before removing reusable equipment from the patient's room, clean and disinfect it thoroughly with a hospital-approved disinfectant

- **Designated Soiled Linen Bin:** Maintain a dedicated bin within the patient care area for soiled linens to prevent contamination of the environment

- **Disposal of Contaminated Supplies:** Upon patient discharge, death, or discontinuation of Contact Precautions, discard any supplies that cannot be effectively disinfected or sterilized

Maintaining a Clean Patient Environment[12, 13]

- **Daily Cleaning and Disinfection:** All horizontal surfaces and frequently touched objects in patient wards should be cleaned and disinfected daily. This includes surfaces like bedside tables, overbed tables, and call buttons

- **Enhanced Cleaning in High-Risk Areas:** In Intensive Care Units (ICU) and High Dependency Units (HDU), cleaning and disinfection of these surfaces should be performed at least once per shift, in addition to daily cleaning

- **Immediate Cleaning of Soiled Surfaces:** Regardless of location, any surface that becomes visibly soiled with bodily fluids or other contaminants should be cleaned and disinfected immediately to prevent the spread of pathogens

Protecting Patients: Guidelines for Visitors[8, 10]

To help keep patients safe from infection, all visitors must be educated to follow these guidelines:

- **Hand Hygiene is Key:** Encourage attendants/visitors to wash hands thoroughly with soap and water or use an alcohol-based hand rub before entering and upon leaving the patient's room
- **Limited Visitors, Please:** For the patient's well-being, limit visits to one healthy adult attendant
- **Restricted Access for Children:** To minimize the risk of infection, children must not be permitted to visit patients on Contact Precautions
- **Protective Gear When Needed:** If assisting with direct patient care, visitors must be encouraged to wear gloves and gowns as instructed by the healthcare team
- **Doffing PPE Before Leaving:** Visitors must be educated to remove PPE (gloves and gowns,etc) and perform hand hygiene before exiting the patient's room
- **Visitor Health Considerations:** Visitors must be discouraged to visit the patient in case of any medical condition that could make them more susceptible to infection

Duration of precautions [14]

- Precautions can only be discontinued once the patient care area has undergone a thorough terminal cleaning
- Precautions should be discontinued only after the patient care area has been terminally cleaned

Safe Handling of deceased bodies[14]

- **Apply Universal Precautions:** Standard Precautions, along with wearing appropriate PPE (gloves, apron, etc), when handling deceased bodies
- **Body Bag for Transport:** The body of a deceased must be placed in a leak-proof body bag before transporting to the mortuary. This helps in minimizing the risk

Linen, Biomedical Waste Management, reusable dishes and eating utensils[6]

Soiled Linen

- Handle, tranport and process linen soiled with blood, body fluids, secretions, or excretions with care
- Wear appropriate personal protective equipment (PPE) to minimize exposure
- Ensure there's no leakage during transport by using leak-proof containers or bags
- Therefore, no special precautions are needed for dishware (e.g., dishes, glasses, cups) or eating utensils

Biomedical Waste:

- Contain biomedical waste like bloody sponges, dressings, and surgical drapes in impervious waste bags. Double bagging might be required as in case of COVID-19 waste
- Dispose them off according to existing Bio-medical Waste Management (BMW) rules

Sharp Items:

- Handle used needles and sharp items with extreme caution to prevent injuries during disposal
- Dispose them off immediately in designated puncture-proof containers located at the point of use

Dishes and Eating Utensils:

- The combination of hot water and detergent is generally sufficient for cleaning dishes and utensils
- No Special precautions needed

of exposure to bodily fluids. (For details please refer to chapter 12-Handling of the Deceased)

Droplet Precautions[8]

- To protect healthcare workers and other patients, droplet precautions are added to standard hygiene practices for patients with certain illnesses. These illnesses spread through large droplets bigger than 5 micrometers, when someone coughs, sneezes, or talks nearby. These droplets can't travel far and require close contact to transmit the illness[8]
- Droplet transmission requires close proximity or contact between the source and the susceptible host
- Droplets may also land on surfaces and then be transferred by contact transmission

Specific Etiologies [15, 16]

- Adenovirus, respiratory strains
- Bocavirus
- Coronavirus
- Diphtheria
- *H. influenzae*, in children
- Human metapneumovirus
- Influenza, seasonal and avian
- Meningococcus
- M-Pox
- Mumps
- *Mycoplasma pneumoniae*
- Parainfluenza virus
- Parvovirus B-19 aplastic crisis or chronic infection in immune-compromised patient
- Pertussis
- Plague, pneumonic
- Respiratory syncytial virus
- Rhinovirus
- Rubella
- Severe Acute Respiratory Syndrome
- Smallpox
- *Staphylococcus aureus* in children with pneumonia
- Streptococcus, Group A
- Scarlet fever or pharyngitis in children
- Viral haemorrhagic fevers (Crimean -Congo, Ebola, Lassa, Marburg)

Droplet precautions include[7]

Droplet precautions are implemented to prevent the transmission of illnesses spread through large droplets generated by coughing, sneezing, or talking. These droplets are too heavy to travel far through the air and typically require close contact to be infectious.

Source Control is key:

Table 10.1: Provisioning hand washing basins in various patient care areas (Source: International Health Facility Guidelines 2022)

Location	Quantity
Ambulatory care units (Chemotherapy, Renal Dialysis)	1 per enclosed bay, 1 per 4 open treatment bays
Emergency Unit	1 per enclosed treatment bay, 1 per resuscitation bay; 1 per 4 open treatment bays
Inpatient Units	1 per single patient room; 1 per room in multi- bedrooms; additional basins provided in corridors (outside patient rooms)
Intensive Care Units(ICUs), High Dependency Units (HDUs) and Cardiac Care Units (CCUs)	1 per single patient rooms 1 per 2 open bays; additional basins provided in corridors (outside patient rooms)
Neonatal Intensive Care (NICU) and Nurseries	1 per bed, enclosed or 1 per 2 open cot spaces; additional basins provided in corridors (outside patient rooms)
Neonatal Special Care Nursey (SCN)	1 per bed, enclosed or 1 per 3 open cot spaces; additional basins provided in corridors (outside patient rooms)
Patient treatment areas	Not greater than 10 meters to a hand washing basin

Table 10.2: Patient placement and accommodation in droplet precautions[15,16]

Single room	• A single room with an in-room designated toilet and sink is preferable[8] • Prioritise patients who have excessive cough and sputum production for single-patient room placement
Cohorting	• When sufficient single rooms are not available, patients should be cohorted if they are known to be infected with the same pathogen and if they are suitable roommates
Share Room – when cohorting is not feasible:	• Maintain spatial separation of at least 2 metres between patients • Privacy curtains between beds should be drawn to minimize opportunity for droplet spread • Patients should be selected based on their ability to comply with precautions • Patients should not be at high risk for serious disease if transmission occurs

A crucial element of droplet precautions is source control. This involves measures to limit the spread of droplets from the infected person:

- **Surgical Mask:** Patients with respiratory infections should wear a surgical mask when they are around others. This helps to contain droplets when they cough, sneeze, or talk
- **Respiratory Hygiene:** Educate patients on proper cough and sneeze etiquette, such as covering their mouth and nose with a tissue or their elbow

Additional considerations:

While the information above focuses on source control, droplet precautions may also include:

- **Point-of-Care Risk Assessment (PCRA):** Healthcare professionals routinely perform a PCRA to determine if droplet precautions are necessary based on a patient's symptoms and potential diagnoses
- **Separate Triage During Outbreaks:** In situations with community outbreaks of respiratory infections, healthcare facilities may create separate entrances or triage areas to isolate and prioritize patients with these symptoms

Hand hygiene

- Perform hand hygiene as per the WHO hand hygiene guidelines. Please refer chapter 2 for details
  - At the point of care
  - At the foot of each patient bed or trolley
  - In clinical areas

Cohorting Patients on Droplet Precautions[7, 17]

Cohorting is a strategy used in infection control to group patients infected with the same organism in the same room. This approach can be beneficial for patients on droplet precautions by:

- **Minimizing risk of transmission to other patients:** By keeping patients with the same infection together, the chances of spreading the illness to other susceptible patients to that specific organism are lowered
- **Optimizing use of resources:** Staff caring for these patients must use the same PPE (personal protective equipment) when moving between patients in the cohort room, thus, reducing the need to repeatedly don and doff PPE

However, implementing successful cohorting requires careful consideration of several factors:

- **Patient compatibility:** Patients within the cohort should be medically stable and able to tolerate being in the same room
- **Adequate space:** The room should be large enough to accommodate all patients comfortably while allowing for proper medical care and minimizing the risk of cross-contamination
- **Hand hygiene:** Rigorous hand hygiene practices are essential for all healthcare personnel entering and exiting the cohort room to prevent transmission between patients
- **Communication:** Patients and their families should be informed about droplet precautions

and the rationale behind cohorting.
Here are some additional points to remember:

- **Single-patient rooms are preferred** if available, but cohorting can be a useful alternative when single rooms are scarce
- **Cohorting should not be used** for patients with weakened immune systems or those at high risk for complications from the shared organism
- **Clear signage** should be posted outside the room indicating the use of droplet precautions and any specific instructions for entering

Personal Protective Equipment (PPE) for Droplet Precautions[7]

- **PPE readily accessible:** Face masks and eye protection (goggles or face shields) should be conveniently located outside the patient's room, cubicle, or designated care area for immediate access by healthcare personnel
- **Donning PPE for Droplet Precautions:** When within 2 meters of a patient who is coughing during interaction, wear a face mask and eye protection in addition to standard precautions (e.g., gloves, gown)
- **PPE within Cohorts:** In a cohort room where patients are infected with the same organism, healthcare providers can reuse the same face protection (mask and eye protection) when moving between patients, provided the PPE remains clean and undamaged. This helps to conserve resources

Cleaning and disinfection of patient care equipment and environment

As per routine practices. If contact precautions are needed, then as per contact precautions.

Management of laundry, dishes and waste

As mentioned above (routine practice).

Protecting patients: Guidelines for visitors[17]

- Educate as per droplet precautions
- Limited visitor and visits
- Wear surgical/N95 mask and eye protection when within 2 metres of patient
- Signage outside the patient's room to provide more detailed instructions about droplet precautions.
- Ensuring hand hygiene practice to be followed

Duration of precautions [8, 17]

Droplet Precautions should be as followed per the pathogen-specific recommendations

Table 10.3: Factors influencing airborne transmission [19, 20, 21]

Temperature	Certain viruses are more active at lower temperatures[19]
Humidity	High humidity levels are protective against UV light destruction as water vapor forms a protective barrier around the droplet nuclei[19]
Airflow and ventilation	Ventilation can reduce the risk of infection through dilution and removal. [19] Better ventilation lowers the risk of transmission of TB and other airborne infections. The direction of airflow from clean to dirty areas and proper distribution of fresh air are also required to prevent the transmission of airborne pathogens [21]
Amount of sunshine	Ultraviolet (UV) rays from of the sun are harmful to bacteria and viruses. The strength and duration of UV light exposure can determine the survival of infectious pathogens in the air [20]

Management of deceased bodies [17]

- To be followed as discussed above. (Please refer to Chapter 12 for details)

Airborne Precautions

Airborne precautions are a specific set of infection control measures used to prevent the spread of illnesses caused by pathogens that can linger in the air for extended periods. These tiny particles, called airborne droplet nuclei, can be inhaled by others thus, causing infection.

Airborne precautions are used in addition to Standard Precautions (like hand hygiene) to create a multi-layered approach to infection control. These precautions are specifically designed for patients with infections that can be transmitted through the air, such as tuberculosis or measles. [5]

Conditions and/or clinical presentations and specific etiologies requiring airborne precautions:

- Tuberculosis
- Measles
- Varicella
- Disseminated zoster

Indicative list of procedures generating infectious aerosolized particles[18]

- Manual ventilation with a bag and mask
- Intubation
- Open endotracheal suctioning
- Bronchoscopy
- Cardiopulmonary resuscitation
- Sputum induction
- Chest physiotherapy
- Lung surgery
- Nebulizer therapy and steam inhalation
- Non-invasive positive pressure ventilation (BIPAP, CPAP)
- Autopsy of the lungs

Terminal Cleaning[17]

Following a patient's discharge from an airborne isolation room, a specific cleaning process is essential to ensure the safety of staff and future patients. Here's a breakdown of the key steps:

Maintaining Negative Pressure:

- **Door Closed:** The room door must remain closed throughout the cleaning process
- **Negative Airflow:** The negative pressure ventilation system should continue to operate for 45-60 minutes (or as per facility protocol) to ensure proper air exchanges. This helps remove airborne contaminants from the room. The exact duration may vary depending on the room size

Minimizing Dispersion:

- **Gloved Cleaning:** Cleaning staff should wear gloves while handling all surfaces and equipment within the room
- **Minimizing Agitation:** Soiled linens and other materials should be handled with minimal agitation to prevent airborne dispersal of microorganisms. Techniques like folding soiled linens inwards will help contain any contamination

Safe Specimen Handling:

- **Infectious Assumption:** All body specimens from the patient should be considered infectious
- **Safe Handling:** Follow standard precautions and facility-specific protocols for the safe handling and transport of specimens. This might involve using leakproof containers and designated transport routes

Additional Considerations:

- **Disinfectant Selection:** Use disinfectants approved by the healthcare facility for effective cleaning against airborne pathogens
- **Personal Protective Equipment (PPE):** Cleaning staff may be required to wear additional PPE like gowns, gloves and N-95 mask depending on the specific facility protocols

Linen, waste, reusable dishes and eating utensils

Same instructions as presented before.

Protecting Patients: Guidelines for patients and visitors

Educating Patients on Airborne Precautions

For patients requiring isolation due to the risk of airborne transmission, education is crucial to minimize the spread of infection. Here are key areas to address:[17]

- **Understanding the Condition:** Patients should be informed about their specific illness and how it can spread through airborne particles
- **Importance of Airborne Precautions:** Explain the purpose of airborne precautions and how they help protect others from getting sick
- **Coughing Etiquette:** Educate patients on proper coughing etiquette to minimize the spread of infectious particles. This may include:
  - Coughing or sneezing into a tissue or their elbow, covering their mouth and nose completely
  - Disposing of used tissues promptly in a lined wastebasket
  - Practicing good hand hygiene after coughing or sneezing
- **Room Restrictions:** Discuss the importance of remaining in the isolation room whenever possible to minimize the risk of transmission to others
- **Communication:** Encourage patients to ask questions and express any concerns they may have

By providing clear and comprehensive education, healthcare providers can empower patients to become active participants in preventing the spread of airborne infections.

Airborne Precautions for Attendants/Visitors

To minimize the risk of spreading infection and ensure the well-being of everyone, certain precautions are necessary for visitors of patients on airborne precautions:

- **Limited Visits:** The number of visitors must be restricted
- **Visitor Screening:** Close contact visitors (e.g., family members) may be screened for any signs of illness before entering the patient's room
- **Visitor Precautions:** All visitors must follow the following airborne precautions
- **Hand Hygiene:** Wash your hands thoroughly with soap and water or use an alcohol-based hand rub before entering and upon leaving the patient's room
- **N95 mask Use :** Educating them on wearing a properly fit-tested N95 mask with a seal check provided by the healthcare staff along with clear instructions on its proper use and disposal
- **Immunocompromised Individuals:** To protect from potential complications, if visitor has a weakened immune system, they must be discouraged to meet the patient

Management Principles

Source control[7]

Airborne precautions are crucial for preventing the spread of illnesses transmitted through tiny airborne particles. Here's how source control plays a vital role:

- **Early Identification:** A system should be established at the first point of contact (e.g., triage) to identify patients with suspected or confirmed airborne infections
- **Patient Cooperation:** Patients with suspected or confirmed airborne infections may be asked to wear a well-fitting triple-layer surgical mask to minimize the spread of respiratory droplets

- **Clear Communication:** A visible sign indicating airborne precautions should be placed at the patient's room entrance

Additionally, a fast-tracking card might be provided to these patients to minimize contact with others.

Minimizing Airborne Transmission During Procedures: For patients requiring procedures that generate aerosols (tiny airborne particles), additional strategies must be implemented:

- **Minimize Personnel:** The number of healthcare workers (HCWs) in the room should be limited only to those essential for the procedure
- **N-95 mask Use:** All personnel present during an aerosol-generating procedure must wear a properly fitted N-95 mask for maximum protection

Hand hygiene

Perform hand hygiene when entering patient care area and when leaving the room as per WHO guidelines. (Refer to Chapeter 2).

Cohorting Patientsis on Airborne Precautions is discouraged [19, 20]

While cohorting (placing patients together) can be a strategy for some precautions, it's generally not recommended for airborne infections due to the high risk of transmission. [22, 23]

Single Rooms with Negative Pressure Ventilation are Essential

- For patients with suspected or confirmed airborne infections, immediate placement in a single **airborne infection isolation room** is crucial. These rooms are specially designed to prevent the spread of airborne pathogens

Key Features of Airborne Infection Isolation Rooms:

- **Negative Pressure Ventilation:** These rooms maintain a lower air pressure than the surrounding areas. This helps to draw air containing infectious particles out of the room
- **High-Efficiency Particulate Air (HEPA) filter:** HEPA filters are highly effective at capturing and trapping tiny airborne particles, including those that can cause infection
- **Venting Options:** The filtered air from the negative pressure system can be either
- **Vented Directly Outside:** This is the safest option, as it completely removes the filtered air from the healthcare facility
- **Recirculated with HEPA Filtration:** In some cases, the filtered air might be recirculated back into the room after passing through a HEPA filter. This option requires careful maintenance of the HEPA filter system

Safe patient transport practices[19]

Minimize patient movement outside the room. Transport only for essential medical procedures. Ensure proper airborne precautions are adhered to while transporting the patient. [1]

Minimizing exposure during transport:

When medically essential transport is unavoidable for a patient on airborne precautions, specific measures are necessary to minimize exposure to other patients and staff:

- **Direct Transport:** Transport teams should coordinate directly with the patient's room to avoid unnecessary waiting times in common areas like reception
- **Dedicated Holding Area:** If a brief holding area is absolutely necessary, it should be a designated space for airborne precautions to prevent contamination of other areas

Patient Transport Considerations:

- The patient should preferably be transported in an empty elevator to minimize the risk of transmission to other patients

- Precautions should be followed throughout the transportation process, including ensuring the patient wears a well-fitting mask (if tolerated) and transport staff wear appropriate personal protective equipment (PPE) as per facility guidelines

- Alert the receiving department that Patient requires Airborne Precautions upon arrival

PPE requirements for HCWs handling patients with airborne infections:[7, 19]

- **An appropriately fit-tested N95 respirator.** The fit test ensures a secure seal for optimal protection

- **Personal protective equipment (PPE):** This typically includes gloves, gown, eye protection (goggles or face shield), and a head cover, depending on the specific facility guidelines

- **Donning and Doffing Procedures:** Healthcare workers must strictly follow established procedures for putting on (donning) and removing (doffing) PPE to minimize the risk of contamination. All used PPE must be disposed of properly before leaving the patient care area. Designated doffing stations are usually located outside negative pressure rooms for safe removal and disposal of PPE

Duration of precautions [7]

The decision to discontinue airborne precautions will be based on established protocols and disease specific recommendations

Handling of deceased bodies[14, 19, 24]

Please refer to Chapter 12-Handling of Deceased.

Airborne Infections Isolation (AIIR) Room[25]

Healthcare facilities utilize specialized rooms called **airborne infection isolation rooms (AIIRs),** also known as negative pressure isolation rooms, to prevent the spread of airborne illnesses.

Key Features of AIIRs:

- **Negative Pressure:** These rooms are designed to maintain lower air pressure than surrounding areas. This creates a directional airflow, drawing air into the room from the hallway

- **Contained Airflow:** When the door is closed and the ventilation system functions properly, air cannot escape the AIIR to other areas of the facility

- **Air Filtration:** Contaminated air from the room can either be:

  - **Exhausted Outdoors:** Ideally, the air is vented directly outside, where tiny airborne particles (droplet nuclei) become diluted and harmless

  - **HEPA Filtration:** Alternatively, the air might be passed through a High-Efficiency Particulate Air (HEPA) filter. This filter traps nearly all (99.97%) of the droplet nuclei before recirculating the air back into the room

Who Needs an AIIR?[22]

Patients suspected or confirmed to have illnesses transmitted through airborne particles are placed in AIIRs. This helps protect both patients and healthcare workers from the spread of these serious infections.

Planning airborne infection isolation room

Ensuring adequate airborne infection isolation rooms (AIIRs) is crucial for healthcare facilities to prevent the spread of serious airborne illnesses. Here's a breakdown of key planning considerations:[26]

Number of Rooms:

- **Minimum Requirement:** All healthcare facilities should have at least one AIIR

- **Risk-Based Approach:** Medical facilities in correctional settings, due to a potentially higher risk environment, should also have at least one AIIR. However, the **ideal number of AIIRs** for any facility should be determined through a comprehensive risk assessment considering factors like number of admissions and local disease prevalence

Air Exchange Rates:

- **Existing Facilities:** AIIRs in existing facilities should maintain an air exchange rate of at least 6 air changes per hour (ACH). This means that the entire volume of air in the room is replaced with fresh air at least 6 times per hour

- **New and Renovated Facilities:** New or renovated facilities are recommended to have AIIRs with an even higher air exchange rate of at least 12 ACH

Increasing Airflow in Existing Rooms:

- **Ventilation System Adjustments:** Where feasible, healthcare facilities can explore modifying their existing ventilation systems to increase the air exchange rate in existing AIIRs to reach the recommended 12 ACH

- **Air Cleaning Alternatives:** For situations where modifying the ventilation system is not possible, alternative air cleaning methods can be considered

- **HEPA Filter Recirculation Units:** These units recirculate room air through HEPA filters, effectively trapping airborne particles while returning clean air back into the room

- **Ultraviolet Germicidal Irradiation (UVGI) Systems:** UVGI systems use ultraviolet light to inactivate airborne pathogens, increasing the effective air exchange rate within the AIIR

Environmental Controls: Secondary controls [25]

In addition to patient isolation, healthcare facilities utilize secondary environmental controls to minimize the spread of airborne pathogens. These controls target the air itself:

- **Airflow Management:** Strategies like negative pressure isolation rooms control airflow direction, preventing contaminated air from escaping into surrounding areas

- **Air Purification:** HEPA filtration and ultraviolet germicidal irradiation (UVGI) are employed to remove or inactivate airborne particles, further reducing the risk of transmission

HEPA Filters[24, 25, 26]

HEPA stands for High-Efficiency Particulate Air. These filters are incredibly effective at capturing airborne particles, including the tiny droplet nuclei that can spread airborne illnesses.

- **Essential for Safe Air Recirculation:** Whenever air from local exhaust systems (like those found in laboratory fume hoods) needs to be recirculated back into the room or surrounding area, HEPA filtration is mandatory. This ensures that any harmful particles are removed before the air is reused

- **Alternative for Negative Pressure Rooms:** In situations where venting exhaust directly outside isn't feasible due to ventilation limitations or building design, HEPA filtration can be used as an alternative solution for negative pressure rooms

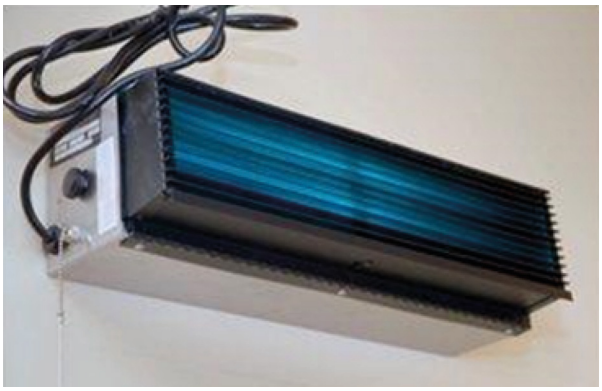
UVGI: Disrupting Germs with Light

- **UVGI stands for Ultraviolet Germicidal Irradiation.** This technology utilizes special lamps that emit germicidal ultraviolet light

- **Inactivates Airborne Pathogens:** This ultraviolet light disrupts the DNA or RNA of airborne pathogens like bacteria and viruses, rendering them inactive and unable to cause infection. In healthcare settings, UVGI is particularly useful for inactivating airborne tuberculosis bacteria present in droplet nuclei

Figure 10.2 High efficiency particulate air filter[25]

Figure 10.3 Ultraviolet germicidal irradiation[25]



Evidence from systematic review

A successful implementation of Transmission-Based Precautions is multifaceted and dependant on proper execution of regular periodic training to healthcare workers. The following are salient inferences extracted from the Systematic Review:

- Healthcare workers should follow Standard Precautions along with additional precautions as necessary (e.g., airborne, contact, use of PPE etc.,) when patients are known or suspected to have a transmissible disease[27]
- Contact Precautions are critical for preventing the spread of Multiple Drug Resistant Organisms (MRDO)[28]
- Measures must be in place to both increase and sustain hand hygiene compliance so as to minimize the risk of nosocomial cross transmission[29]
- By ensuring prompt isolation and adequate avialbility of PPEs (contact precaution supplies) healthcare workers are more likely to adhere to these infection control practices[30]
- Distribution of inexpensive Summary Cards is an effective mechanism for improving point-of-care access to Transmission-based Precautions guidance and decision-making about appropriate implementation of TBP[31]
- Effective infection prevention requires continuous learning for healthcare workers (HCWs). Incorporating IPC training throughout their careers and evaluating its effectiveness ensures updated knowledge. Additionally, national guidelines that consider adult learning principles can standardize training development across facilities. This two-pronged approach of ongoing, relevant training and clear national guidance strengthens infection prevention efforts to protect both patients and HCWs[32]
- A cautious and well-considered approach to surgery offers a double benefit. Firstly, it minimizes potential risks to patients and the HCWs. Secondly, by opting for necessary procedures only, hospitals conserve vital resources like staff, beds, and equipment. This allows for a more effective response during unforeseen crises, where these very resources become critical[32]

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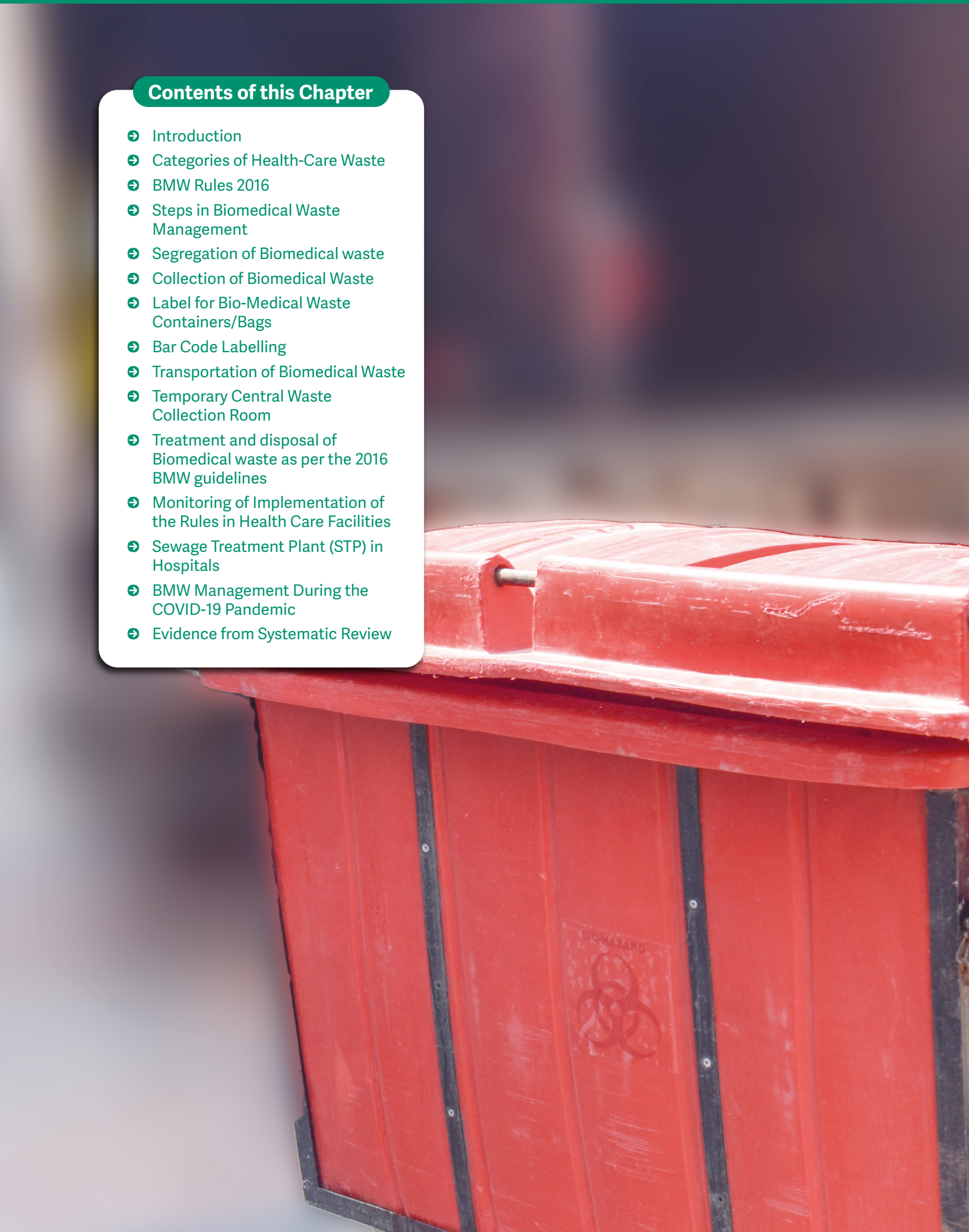
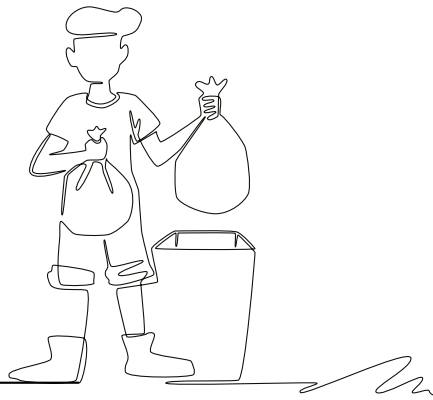


Picture Credit: AIIMS, New Delhi

Chapter 11

Biomedical Waste Management

Biomedical Waste Management



Biomedical waste

Biomedical waste (BMW) is any waste produced during the diagnosis, treatment, or immunization of human or animal research activities pertaining thereto or in the production or testing of biological or in health camps BMW does not include.[1]

- Radioactive wastes
- Hazardous chemicals
- Solid wastes
- Lead acid batteries
- Hazardous wastes
- e-Waste
- Hazardous microorganisms, genetically engineered microorganisms and cells.

Biomedical waste management is the process of responsibly handling, treating, and disposing of waste generated throughout healthcare.

Biomedical waste, generated during healthcare activities, poses significant health risks due to its potential to contain infectious agents and hazardous materials. Proper management and disposal are critical to safeguard the environment, the general public, and especially healthcare workers who handle this waste daily. The ever-growing volume of biomedical waste demands stricter attention to safe disposal practices. These practices minimize risks and prevent negative consequences for human health and the environment.

Goals of the Biomedical Waste Management[1]

The goals of biomedical waste management are focused on mitigating health and environmental risks associated with the disposal of medical waste. The key objectives include

- Reduce infectious/hazardous of the waste
- Reduce waste volume
- Prevent misuse or reuse of waste
- Ensure occupational safety and health of workers
- Reuse items of repeat utility

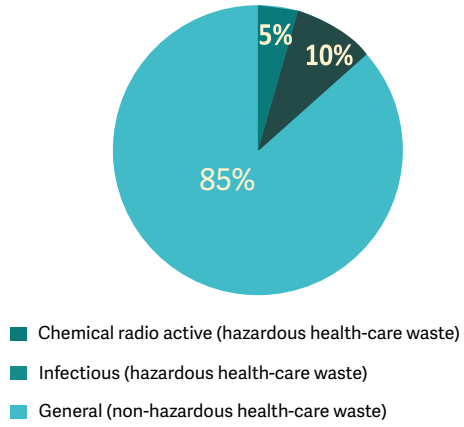
Categories of health-care waste

1. Hazardous Health-Care Waste:
    - Sharps Waste: This includes any sharp objects that could cause injury, such as used needles, scalpels, and broken glass. These items should be handled with care to prevent accidental pricks
    - Infectious Waste: This category contains materials that could potentially spread diseases. It includes items contaminated with blood, such as bandages or dressings, as well as waste from patients who are being treated for infectious diseases
    - Pathological Waste: This type of waste consists of human body parts, tissues, fluids, and unused blood products. Proper disposal is crucial to prevent the spread of disease and ensure respect for human remains

- Pharmaceutical and Cytotoxic Waste: This includes expired medications and items contaminated with drugs, particularly those used in cancer treatment (cytotoxic drugs). These medications can be harmful if not disposed off properly
- Chemical Waste: This category includes leftover chemicals used in laboratories, such as reagents for tests. It also contains expired disinfectants and containers that held heavy metals. Safe disposal is important to avoid environmental contamination and potential harm to human health
- Radioactive Waste: This type of waste contains materials that emit radiation, which can be harmful if not handled carefully. Examples include items used in radiation therapy for cancer treatment and materials contaminated with radioactive isotopes in research labs. Strict regulations govern the handling and disposal of radioactive waste to ensure public safety

2. Non-Hazardous or General Health-Care Waste:
    - Includes waste that doesn't pose significant biological, chemical, radioactive, or physical hazards. Examples include paper towels, used packaging materials, and non-contaminated healthcare items like plastic cups or bedpans. While not hazardous themselves, these items are still considered biomedical waste because they originate from healthcare settings

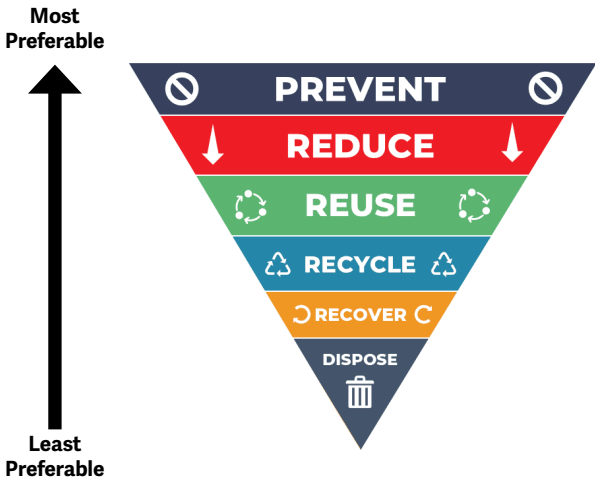
Figure 11.1 Typical waste composition in Healthcare Facilities



Waste Hierarchy [1]

The waste hierarchy prioritizes environmentally friendly waste management practices. It emphasizes strategies that minimize waste generation in the first place, aligning closely with the concept of the "3Rs": Reduce, Reuse, and Recycle. This approach promotes sustainable resource use and minimizes environmental impact.[1]

Figure 11.2 Waste hiearachy



BMW Rules 2016

The Bio-medical Waste Management Rules (BMW Rules), enacted in 2016 by the Ministry of Environment, Forest and Climate Change, serve as a comprehensive framework for handling healthcare waste. These rules encompass various aspects crucial for safe and environmentally sound waste management. Responsibilities are clearly defined for both healthcare facilities and operators who treat biomedical waste at Common Bio-medical Waste Treatment Facilities (CBMWTFs). The BMW Rules establish proper procedures for segregating different waste types, ensuring their safe storage and transport, and ultimately disposing of them through approved treatment methods. Furthermore, the rules set emission standards for treatment facilities to minimize environmental impact. Also, mechanisms are outlined for monitoring compliance and ensuring the effective implementation of these critical guidelines in everyday healthcare operations.

Prime stakeholders involved in Biomedical Waste Management[2]

- **Occupier**: This individual or authority holds the responsibility of ensuring that proper biomedical waste management practices are followed on-site. This includes adhering to all relevant guidelines set forth by regulations, as well as implementing staff training programs to ensure everyone involved understands the proper handling and disposal of biomedical waste
- The duties of the Occupier include
  - Implementing procedures that adhere to government guidelines for proper handling, treatment, and disposal of biomedical waste
  - Providing a designated storage location that is well-ventilated, secure, and meets all regulatory requirements of biomedical waste
  - Implementing on-site procedures for pre-treating or sterilizing certain biomedical waste categories as per regulations. Ensuring the safe transport of biomedical waste to designated treatment facilities
  - Maintaining a strict system to prevent treated biomedical waste from ever being mixed with regular municipal solid waste
  - Providing comprehensive training programs for all healthcare workers involved in handling biomedical waste. This training should cover proper handling procedures, safety protocols, and the importance of personal protective equipment (PPE)
  - Additionally, the Occupier is responsible for ensuring healthcare workers receive necessary immunizations (e.g., tetanus and Hepatitis B) and regular health checkups
  - Implementing measures to ensure the occupational safety of healthcare workers handling biomedical waste. This may involve providing appropriate PPE, establishing safe handling procedures, and conducting risk assessments
  - Maintaining a comprehensive daily register that tracks all biomedical waste generated at the facility. Additionally, the Occupier is responsible for making the annual report and monthly records publicly available on the website, as mandated by the BMW rules
  - Promptly reporting any major accidents involving biomedical waste and documenting the corrective actions taken. Relevant records must be maintained as per BMW regulations
  - Establishing a system for regularly reviewing and monitoring all activities related to biomedical waste management within the facility

Figure 11.3 Summary of BMW Management

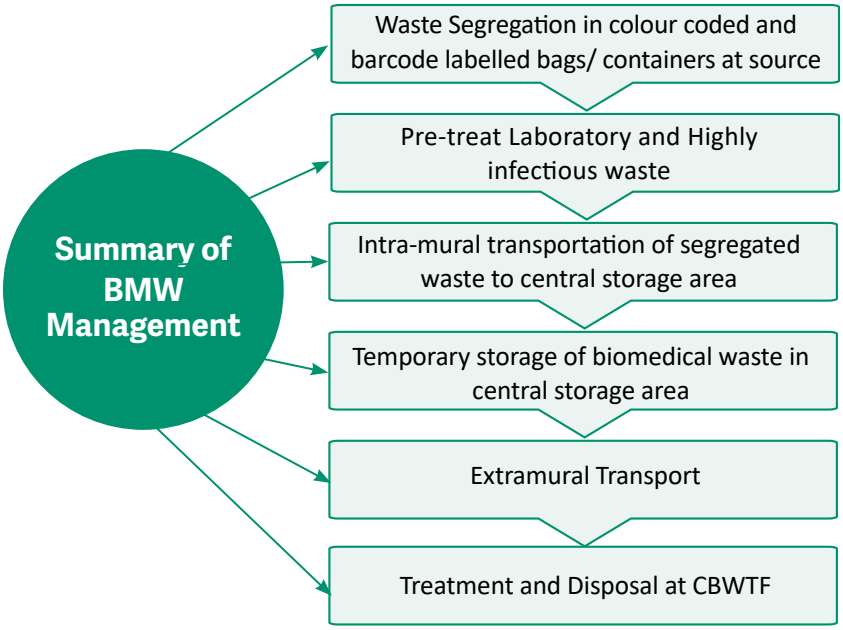


Figure 11.4 Synopsis of the Healthcare waste stream

Step	Location	Healthcare waste stream	Key points
0		Waste Minimization	Purchasing policy; stock management; recycling of certain types of waste..
1	Health care Facility/ Health care unit	Generation	One of the most important steps to reduce risks and amount of hazardous waste
2		Segregation at source	Protective equipment; sealed containers; specific easy to wash trolleys
3		Collection+ on-site transport	Lockable easy to clean storage room; limited storage time of 24-48 hours
4		On-site storage On-site treatment /disposal*	Adequate storage room; limited time of max 48 hours
5		Off-site transport	Appropriate vehicle and consignment note; HCF is informed about final destination
6	Outside of health facility	Off-site treatment and disposal	
7			Appropriate vehicle and consignment

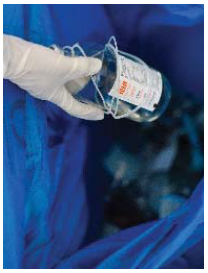
* As per BMW rules & regulations

Figure 11.5 Biomedical Waste Management process[3]

Step -1

BMW is collected from various sites in healthcare facility



Step -2

Waste is collected from colour coded bins and the bags are loaded on to trolleys



Step -3

Trolleys from all over the hospital transport the waste and is stored in the temporary storage facility (for less than 48hrs)



Step -4

Bags are weighed and bar coded

Step -5

All collected bags are loaded on to special Bio Medical Waste Trucks and are transported to common BMW Treatment facility

Figure 11.6 Safe Handling of Lab Waste: Pre-treatment onsite before disposal

1.
Bio-Medical Waste generated from the various laborotories

3.
The bags containing Lab Waste are then transported to the temporary storage facility to be disposed off along with other Bio Medical Waste from other areas of the hospital

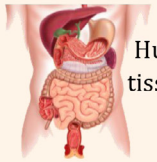
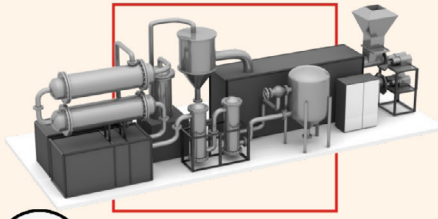
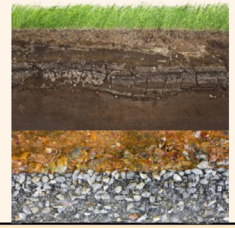
2.
The bags are loaded in a microwave and are Pre-Treated as per specified guidelines

Segregation should [4]

- Always take place at the point of generation
- Be handled by personnel doning requisite PPE
- Be simple to implement, well understood and well known by the medical and ancillary staff
- Be regularly monitored to ensure that the proper practices are followed

Table 11.7 : Colour coding and type of container/bags and contents to be segregated

YELLOW COLORED BINS

Type of bin used	Type of bag/ containers used	Type of waste	Treatment and disposal options
	  *Cytotoxic drugs are to be separately disposed of in a bin marked with a* CYTOTOXIC *symbol*	**Human Anatomical Waste**  Human Organs, tissues and body parts  Fetus below the viability period **Animal Anatomical Waste**  Experimental animal carcasses, body parts, organs, tissues  Waste generated from animals. **Soiled Waste**  Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs  Bags containing residual or discarded blood and blood components. **Expired or Discarded Medicines**  Pharmaceutical waste like antibiotics, cytotoxic drugs  Contaminated glass or plastic ampoules, vials etc.	Incineration OR  Plasma Pyrolysis  OR Deep Burial  Return to the manufacturer OR *Incineration*

Curated by Dr. Paavan Gopathoti

Contd. on next page

Table 11.7: Colour coding and type of container/bags and contents to be segregated

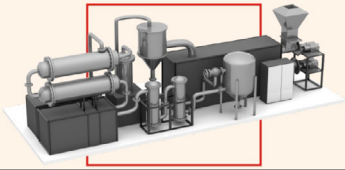
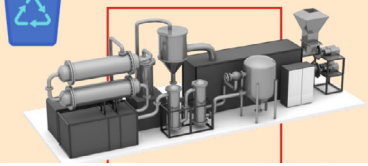
YELLOW COLORED BINS			
Type of bin used	**Type of bag/ containers used**	**Type of waste**	**Treatment and disposal options**
	  OR Suitable packing material *(for linen, mattresses and beddings)*	Chemical Waste    Chemicals used in production of biological and used or discarded disinfectants. Linen  Discarded linen.  Beddings  Blood-Stained Mattresses	Incineration Encapsulation  OR   Plasma Pyrolysis Non-chlorinated chemical disinfection Incineration  OR Plasma Pyrolysis 

Table 11.7 : Colour coding and type of container/bags and contents to be segregated

OTHER YELLOW COLOR-CODED WASTE

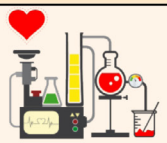
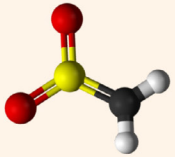
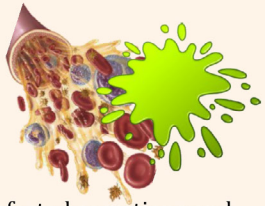
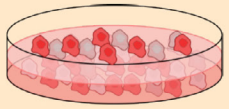
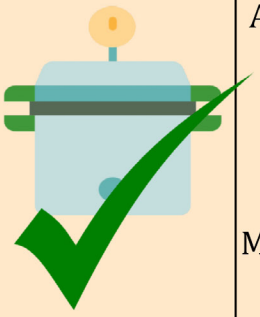
Type of waste	Handling	Treatment and disposal options
Chemical liquid waste  Chemicals used in production of biological and used or discarded disinfectants.  Discarded formalin  Silver X-Ray developing liquid  Liquid from floor washings, cleaning, house keeping and disinfecting activities  Infected secretions and aspirated body fluids	A separate collection system leading to the Effluent Treatment System 	Resource recovery  Mix with other waste water*  **The combined discharge shall conform to the discharge norms of Schedule-III given in Biomedical Waste Management Rules of 2016*
 Blood bags  Specimens of microorganisms  Live or attenuated vaccines  Dishes and devices used for cultures  Lab culture waste  Human or animal cell cultures  Residual Toxins	Autoclave and microwave safe plastic bags or containers 	Autoclave  OR Microwave  Incineration 

Table 11.7 : Colour coding and type of container/bags and contents to be segregated

RED COLORED BINS

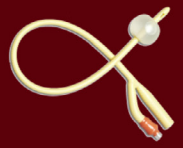
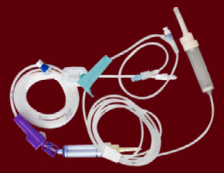
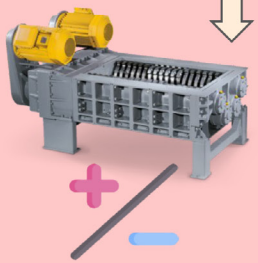
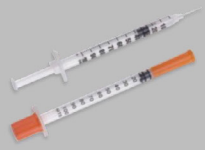
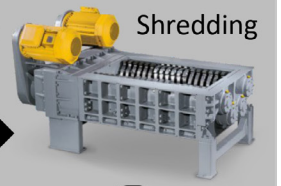
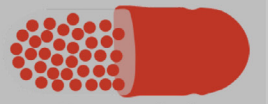
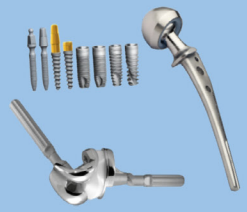
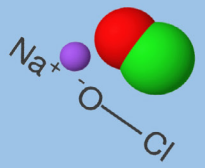
Type of bin used	Type of bag/ containers used	Type of waste	Treatment and disposal options
	 	Recyclable contaminated waste  Tubing  Catheters  Urine bags  IV Sets  Vacutainers  Bottles  Syringes without needles  Fixed needle Syringes with needles removed  Gloves	Autoclave Microwave  OR   Shredding OR  Sterilization + Shredding  Sent to authorized recycler or for energy recovery or plastics to diesel or fuel or for road making

Table 11.7 : Colour coding and type of container/bags and contents to be segregated

WHITE COLORED CONTAINERS

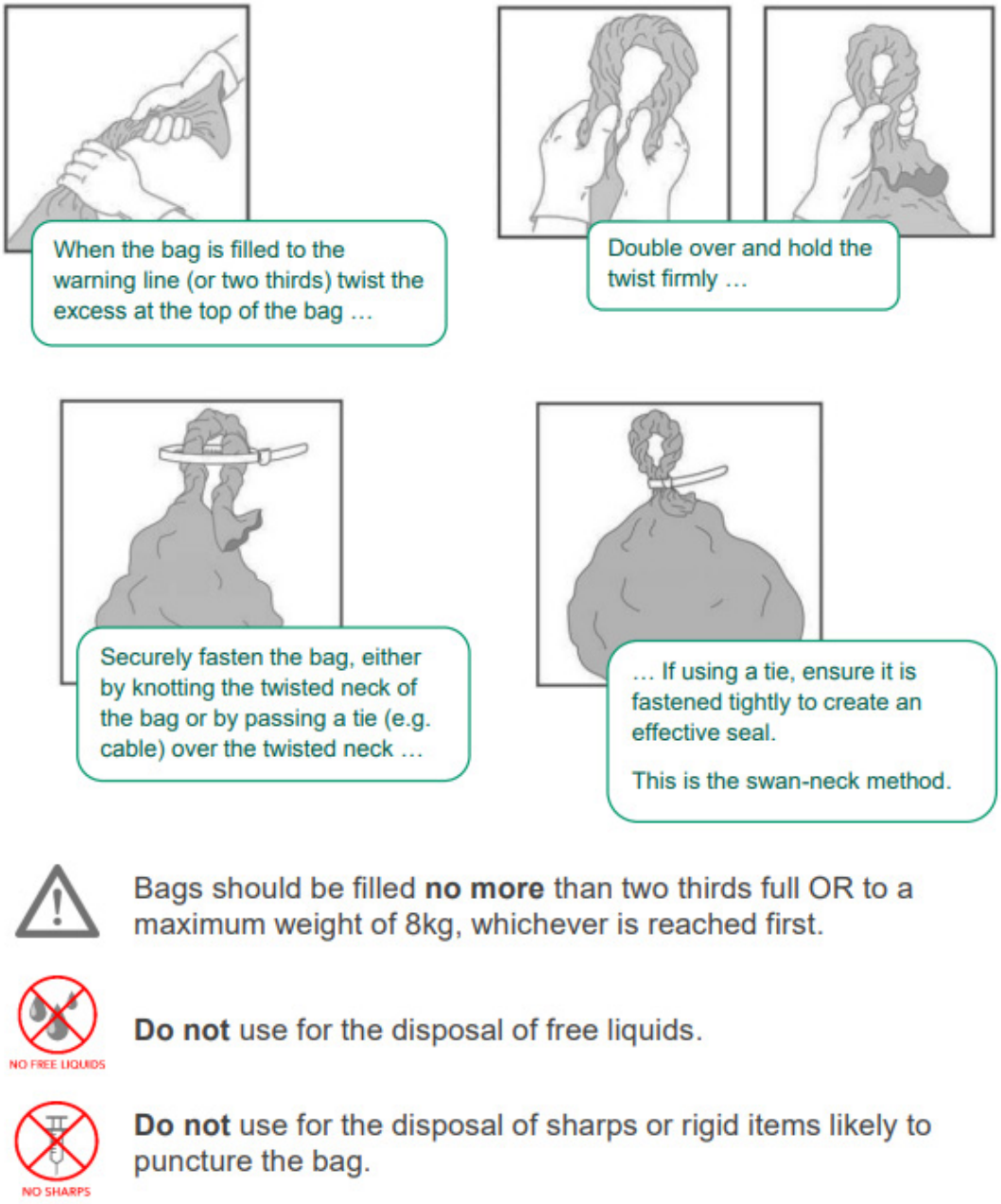
Type of container used	Type of waste	Treatment and disposal options
	Waste sharps including metals  Needles  Fixed needle syringes  Scalpels and blades	Autoclave  OR Dry heat sterilization  Shredding  OR Iron foundries Sanitary landfill Concrete waste pit  Encapsulation

CARDBOARD BOXES WITH BLUE COLORED MARKING

Type of container used	Type of waste	Treatment and disposal options
	Glassware  Medicine vials and ampoules  Broken or discarded glass Metallic Body Implants 	 Disinfection with detergent and Sodium hypochlorite OR  Autoclave  Microwave  Recycling

- **Operator of Common Bio-medical Waste Treatment Facility (CBMWTF):** The Operator of a Common Bio-medical Waste Treatment Facility (CBWTF) is the person or organization responsible for managing a facility that handles biomedical waste. These facilities handle a range of activities including:
  - Collection of biomedical waste from healthcare facilities
  - Receiving and processing waste upon arrival
  - Secure storage of biomedical waste on-site
  - Safe transportation of waste (intramural)
  - Treatment and disposal of biomedical waste using approved methods

Figure 11.8 Securing disposal bags using swan neck tie technique *(Image source: NHS)*



- **The duties of the CBMWTF Operator include**
  - Ensuring timely collection of biomedical waste from healthcare facilities
  - Processing, treatment, and disposal of the waste using methods that adhere to the latest guidelines set forth by the Central Government
  - Providing comprehensive training programs for all personnel employed at the CBWTF facility
  - CBWTF Operators should allow Occupiers to observe and verify that the treatment of biomedical waste at the facility adheres to all prescribed regulations. This transparency helps build trust and ensures all parties involved are aware of their responsibilities

- **Prescribed Authority:** State Pollution Control Boards and Committees act as the primary enforcement body in their respective regions. They are responsible for:
- Formulating guidelines for biomedical waste management within their jurisdiction
- Allocating funds to support proper waste management practices
- Monitoring healthcare facilities and CBWTF Operators to ensure compliance with regulations
- DGAFMS: The Directorate General of Armed Forces Medical Services serves as the Prescribed Authority for managing biomedical waste within the Indian Armed Forces

Additional Stakeholders:

- Local Municipal Bodies: Play a role in ensuring proper disposal of non-biomedical waste generated by healthcare facilities
- Regulatory Bodies: Besides pollution control boards, other regulatory bodies may have specific mandates related to certain types of biomedical waste such as radioactive materials
- Environmental Organizations: Advocate for environmentally sound practices in biomedical waste management and raise public awareness about the importance of proper waste handling
- Research Institutions: Play a crucial role in developing new technologies and treatment methods for biomedical waste

Steps in Biomedical Waste Management

Segregation of Biomedical waste

The key to the effective management of healthcare waste is segregation of the waste at the point of generation.[1] "Point of Generation" means the location where wastes initially generate and accumulate in the process of providing care and treatment to the patient.

"Segregation" means separating different wastes into different color-coded bins with liners or sharps containers at locations where they are generated.[2]

Collection of Biomedical Waste[2]

Once segregated at the source, biomedical waste is collected in designated color-coded containers or bags that correspond to the specific waste category. These collections should happen daily to minimize storage time and potential risks. To ensure safety during handling, biomedical waste containers must be strong, leak-proof, and able to withstand potential breakage.

- Nursing and other staff responsible for waste collection should ensure waste bags are tightly sealed once they are about three-quarters full. This helps prevent spills, leaks, and odor release. Important: Avoid closing bags with staples, as it can puncture the material and compromise its safety
- All waste bags used in the healthcare facility must comply with Bureau of Indian Standards (BIS) specifications. This ensures they meet the necessary strength and safety requirements. Furthermore, the minimum thickness of these color-coded bags should be 50 microns, as outlined in the CPCB guidelines (2018)

Label for Bio-Medical Waste containers/bags [5]

The Central Pollution Control Board (CPCB) guidelines mandate specific information to be displayed on the labels of biomedical waste containers or bags. This ensures clear communication and promotes safe handling practices. Here's a key element required on the label:

- Universal Biohazard Symbol: This internationally recognized symbol prominently displayed on the label signifies that the contents are biological hazards and require careful handling

Figure 11.9 Label for biomedical waste containers or bags

- Waste Category: Clearly identifying the waste type (e.g., sharps waste, anatomical waste, microbiology waste) allows for proper handling and disposal procedures
- Date and Time of Collection: This ensures timely disposal and minimizes storage risks
- Unique Barcode (optional): Barcodes can be used for tracking waste movement within the facility and throughout the disposal process, improving overall efficiency
- Facility Name and ID: This helps identify the origin of the waste for accountability purposes
- Contact Information: Including the facility address and phone number provides essential contact details in case of emergencies or inquiries
- CPCB Logo: The presence of the CPCB logo signifies compliance with regulatory guidelines established by the Central Pollution Control Board

Bar Code Labelling[5]

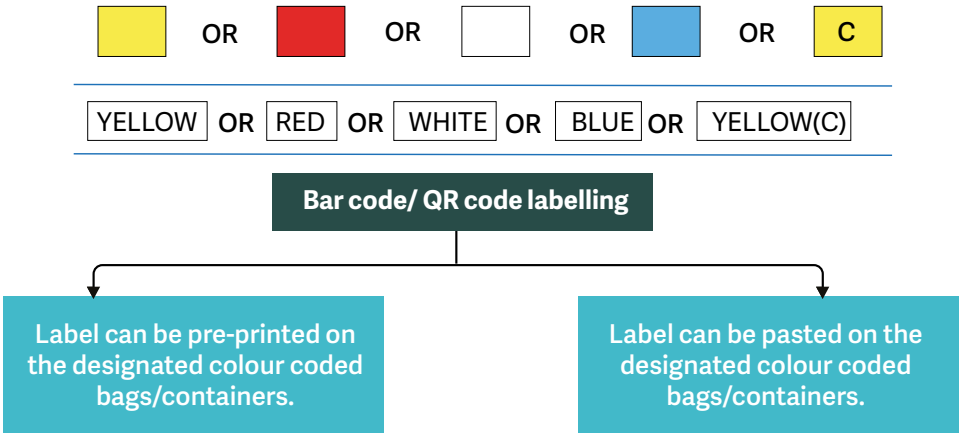
Bar code/ QR code labelling system

Following the collection of biomedical waste from healthcare facilities, a standardized system utilizing barcodes and labels should be implemented. These unique identifiers affixed to each waste container function as individual markers for each batch of waste.

Colour mark on the label

To facilitate easy and immediate identification by healthcare workers handling biomedical waste, the barcode label should incorporate a color code. This colored mark or text, ideally placed in the top left corner of the label, serves as a visual cue to quickly categorize the waste type. This color coding system complements the information encoded in the barcode and the text on the label, providing a multi-layered approach for waste identification.

Figure 11.10 Colour mark on the level[5]



Bar code label specifications[5]

- For optimal visibility, the label should be positioned centrally or close to the center of the color-coded bag or container. This ensures easy identification during handling
- Black text on a white background provides the highest contrast for clear legibility, even in less than ideal lighting conditions
- The label material should be tamper-proof, waterproof, and fade-resistant for at least 48 hours. This ensures that the information

Figure 11.11 Label for transporting biomedical waste bags or containers
(Part B Schedule IV of Biomedical Waste Management Rules, 2016)

Part B

LABEL FOR TRANSPORTING BIO-MEDICAL WASTE BAGS OR CONTAINERS

Day .....Month .....
Year .....
Date of generation .....

Waste category Number .....
Waste quantity……

Sender's Name and Address
Phone Number .....
Fax Number.....
Contact Person .....

Receiver's Name and Address:
Phone Number .....
Fax Number .....
Contact Person .....

In case of emergency please contact :
Name and Address :
Phone No.

Note :Label shall be non-washable and prominently visible.

Figure 11.12 Waste collection/ transfertation trolleys

remains intact throughout storage, transportation, and potential exposure to harsh conditions

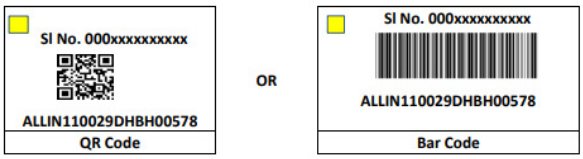
- The label material should withstand prevailing atmospheric temperatures without warping or losing adhesion
- An acrylic-based, pressure-sensitive, tear-resistant adhesive is a suitable option as it adheres securely during handling without compromising safety

Label sequence number[5]

- To ensure the traceability of biomedical waste, Centralized Bio-medical Waste Treatment Facilities (CBWTFs) utilize a central software system for generating unique label sequence numbers. These unique identifiers are then provided to label vendors or used for in-house label production by the CBWTF operator
- For verification purposes, State Pollution Control Boards (SPCBs) or Pollution Control Committees (PCCs) may require CBWTFs to maintain detailed records of label sequence numbers and the corresponding recipients

Example:

- Consider AIIMS, a bedded hospital located in New Delhi. The hospital would be assigned a unique facility code (e.g., 00578). Biomedical waste containers originating from AIIMS would then be labeled with barcodes or QR codes that incorporate this unique identifier, facilitating waste tracking and ensuring proper disposal

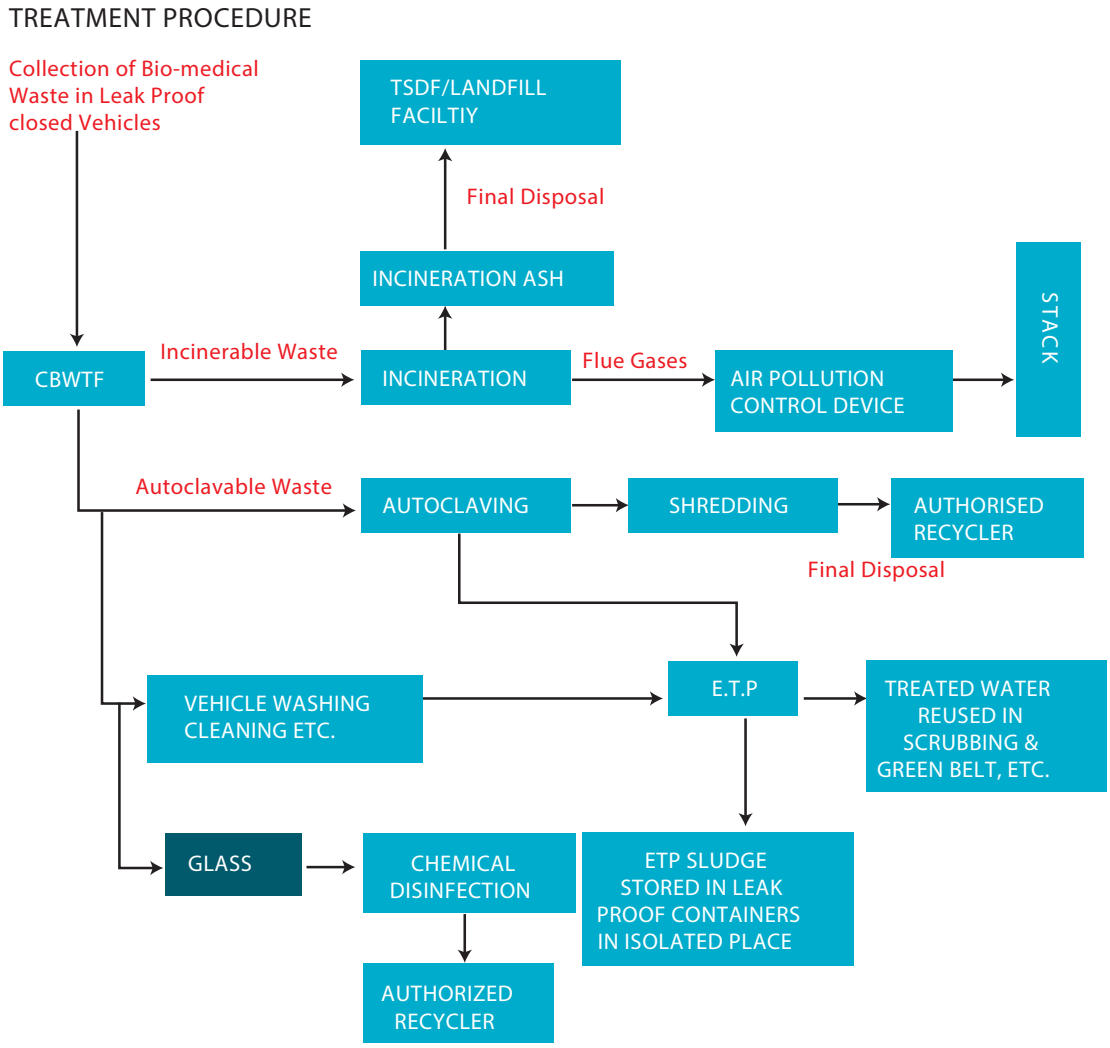


Benefits of barcode system[5]

Benefits of barcode System in Biomedical Waste Management

- Enhanced Traceability and Management: Barcodes enable real-time tracking of waste movement, ensuring proper disposal and fostering accountability (reduced human error)
- Improved Regulatory Compliance: Real-time data facilitates adherence to regulations regarding waste handling and disposal
- Transparency in Waste Management: Barcode systems provide a clear audit trail, ensuring transparency throughout the waste management process
- Streamlined Operations and Sorting: Barcodes simplify waste sorting and improve operational efficiency for both healthcare facilities and CBWTFs
- Reduced Human Contact with Hazardous Waste: By streamlining processes, barcode systems minimize the need for direct handling of hazardous waste
- Data-Driven Decision Making: Data collected through the barcode system can be analyzed to optimize waste management practices

Figure 11.13 Flow chart showing process for disposal of bio-medical waste at common treatment site *(Image credit : AIIMS, New Delhi)*



- Cost Savings: Improved efficiency and reduced errors lead to long-term cost savings for healthcare facilities
- Standardization: Barcodes promote a standardized approach to waste management across healthcare facilities

Necessities for implementing the Bar Code System

- While the procurement department of the healthcare facility is responsible for purchasing the system hardware (digital weighing machines and barcode scanners), both the Occupier (healthcare facility) and Operator (CBWTF) share certain responsibilities
- Digital Weighing Machines: Facilities with 30 or more beds require their own digital weighing machine (potentially Bluetooth-enabled) to weigh waste before disposal and integrate data with the labeling system
- Barcode Scanners: Facilities exceeding 30 beds also need to procure barcode scanners for reading the codes on waste containers

- Exemption for Smaller Facilities: Healthcare facilities with less than 30 beds are not required to have their own scanners. The CBWTF operator will scan these waste bags upon arrival at the treatment facility

Interim storage[2, 7]

Interim storage refers to the temporary holding of biomedical waste (BMW) at a healthcare facility before it undergoes final treatment and disposal. This temporary storage period is crucial for ensuring proper waste management and minimizing risks.

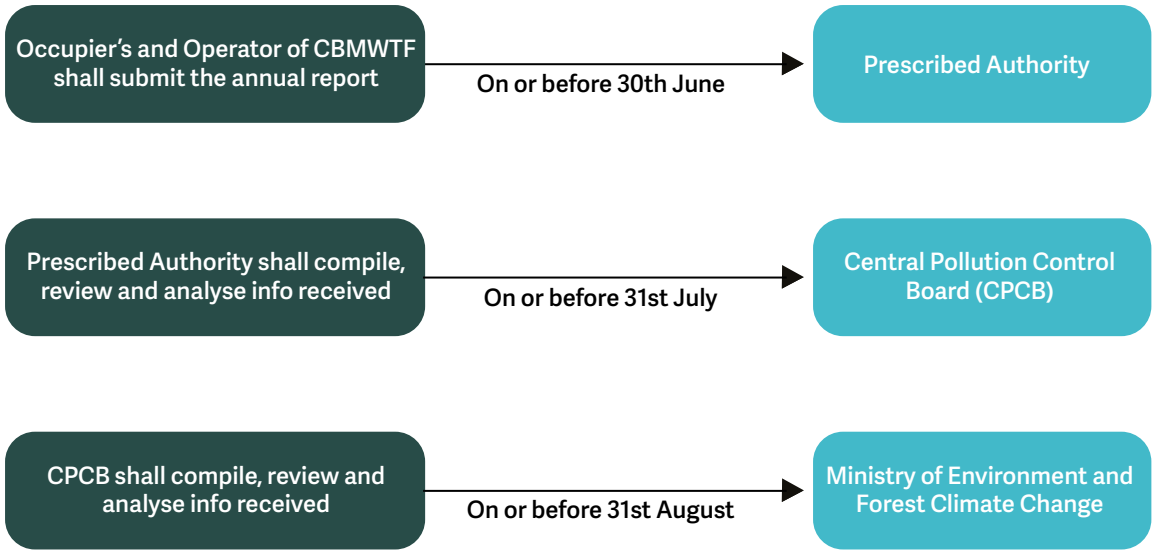
- Maintain strict segregation of different waste categories within the interim storage area. Utilize color-coded bins or containers specifically designated for each waste type, as mandated by regulations
- Discourage the storage of biomedical waste within patient care areas like operating rooms (OTs) and intensive care units (ICUs) to minimize the risk of exposure for patients and healthcare workers
- If interim storage within patient care areas is unavoidable, utilize designated low-traffic areas or sluice rooms that are separate from patient and visitor traffic flow
- For high-risk areas like OTs and ICUs, prioritize the prompt removal of infectious waste to minimize the potential for contamination
- Infectious waste generated in high-risk areas like operating rooms (OTs) and intensive care units (ICUs) should be prioritized for prompt removal and transport to the designated interim storage location

Transportation of biomedical waste [2]

Transporting biomedical waste within a healthcare facility (intramural transport) requires strict adherence to specific protocols to minimize risks and ensure safety. Here are key guidelines to follow:

- Utilize covered and wheeled trolleys, carts, or containers specifically designed for waste transport
- The design of the designated vehicles should facilitate effortless loading and unloading of waste containers to minimize manual handling and potential spills
- The carts should be easy to clean and disinfect, promoting proper hygiene practices and preventing contamination spread

Figure 11.14 Submission of annual report & documents



- The absence of sharp edges helps prevent accidental damage to waste bags, minimizing the risk of exposure to infectious materials
- To prevent cross-contamination, ensure the carts, trolleys, or containers used for waste transport undergo thorough cleaning and disinfection daily using appropriate disinfectants. This routine maintenance minimizes the risk of pathogens spreading throughout the healthcare facility

Temporary central waste collection room [5]

Biomedical waste generated throughout the facility is collected and stored centrally in this room. This room serves as the central collection point for biomedical waste, ensuring proper storage before disposal.

- The storage area should be located away from public and visitor areas to prevent unauthorized entry
- The room should be locked at all times to further restrict access and deter potential theft or tampering
- Consider assigning personnel to guard the entrance/exit for additional control
- The floor should be constructed from a hard, non-porous material (e.g., concrete) for easy cleaning and disinfection
- An effective drainage system is essential to prevent spills and ensure proper hygiene
- The storage area should have separate, designated areas for handwashing and cleaning waste transport trolleys. This promotes proper hygiene practices for staff handling biomedical waste
- Measures should be implemented to prevent access by animals, insects, and birds. This may involve sealing entry points and utilizing appropriate deterrents
- An exhaust fan system is crucial to maintain proper air circulation and prevent the build-up of odors or harmful contaminants
- The storage area should have sufficient space to accommodate the anticipated volume of biomedical waste for a period of 48 hours, as per regulations
- An accessible entrance with a concrete ramp facilitates the easy movement of waste collection trolleys, minimizing manual handling risks
- The storage area should be equipped with appropriate fire safety equipment such as a fire extinguisher and smoke detector to ensure preparedness in case of emergencies
- Should undergo regular pest control and monitoring

Treatment and disposal[2]

Common Biomedical Waste Treatment Facilities (CBWTFs) play a crucial role in the safe and responsible disposal of biomedical waste. These facilities utilize various treatment methods to render the waste non-hazardous or significantly reduce its risk profile, ensuring safe disposal. The specific method employed depends on the waste category and its unique characteristics. Here are some of the most common treatment technologies used in CBWTFs:

- Incinerator
- Microwave
- Autoclave
- Hydro-clave
- Plasma torch technology
- Medical waste sterilization unit

Limitations

- While effective for a broad range of waste types, incineration is not suitable for materials containing heavy metals or plastics. Incomplete combustion of these materials can release harmful pollutants into the environment
- Microwave technology offers a rapid disinfection solution for certain waste categories. However, its limitations include the inability to process large metal objects or body parts due to size constraints

- Autoclaves are effective for disinfecting certain types of biomedical waste using steam sterilization. However, this method does not reduce the overall volume of the waste and may even increase weight due to added moisture content
- Plasma torch technology offers a highly efficient and safe method for waste treatment. However, the high cost of installation and operation makes it a less common option for many CBWTFs
- Hydroclaves offer a relatively cost-effective solution for waste disinfection. However, similar to autoclaves, they are not suitable for processing large anatomical waste due to capacity limitations

Hence, one must look for multiple options instead of basing the waste treatment system only on one option.

Final Disposal[2]

Following effective treatment at Common Biomedical Waste Treatment Facilities (CBWTFs), biomedical waste can be safely disposed of using various methods. Here's an overview of the common options:

Treatment Methods:

- Chemical Treatment: This method utilizes chemical disinfectants to decontaminate specific waste categories, including sharps, solid waste, liquid waste, and chemical waste
- Autoclaving/Microwaving utilizes steam or microwave technology for disinfection. They are suitable for sharps waste, microbiology/ biotechnology waste, soiled waste, and some solid waste categories
- Treated waste, such as human anatomical waste, animal waste, microbiology/ biotechnology waste, and certain solid waste, can be incinerated in controlled facilities to minimize emissions and ensure complete destruction
- Certain non-hazardous, treated biomedical waste, such as discarded medicines, incineration ash, and specific chemical solid waste (e.g., mercury), can be disposed of in designated secured landfills adhering to strict regulations
- Liquid waste, chemical liquid waste, and cytotoxic waste should never be diluted and discharged into public sewers due to their potential toxicity and mutagenic properties. These categories require specific treatment processes before potential final disposal options can be considered

Monitoring of implementation of the rules in health care facilities [1, 2]

To ensure effective enforcement, the Ministry of Environment, Forest and Climate Change (MoEF&CC) will conduct an annual review of the implementation of these rules across the country. This review will be facilitated through State Health Secretaries and the Chairpersons or Member Secretaries of both State Pollution Control Boards (SPCBs) and the Central Pollution Control Board (CPCB).

- **Annual report:** Deadlines for submission and handling of annual reports by various stakeholders are specified in Figure 11.14. These reports provide a comprehensive overview of waste management practices throughout the year
- **Daily report:** Healthcare facilities and CBWTFs are obligated to generate daily reports on the volume of biomedical waste collected, treated, and disposed off. This ensures real-time monitoring of waste management activities
- **Accident reporting:** In the unfortunate event of a major accident involving biomedical waste handling at any institution, facility, or other site, the authorized person must immediately notify the designated authority. Within 24 hours, a written report detailing the accident and the remedial actions taken should be submitted
- **Maintenance of records:** Authorized personnel are responsible for maintaining comprehensive records for a period of five years. These records should document all aspects of biomedical waste handling, including generation, collection, reception, storage, transportation, treatment, disposal, and any other relevant details

Legal framework related to BMW management :

- The Environment Protection Act, 1986
- Biomedical Waste (Management and Handling) Rules in July 1998
- Biomedical Waste (Management and Handling) Rules revised in 2011
- Biomedical Waste (Management and Handling) Rules revised in 2016
- Biomedical Waste (Management and Handling) Rules revised in 2018
- Revision 5 Guidelines for Handling, treatment and disposal of waste generated during treatment, diagnostics and quarantine of COVID-19 patients
- Revision 4 Guidelines for Handling, treatment and disposal of waste generated during treatment, diagnostics and quarantine of COVID-19 patients

- The law works on a simple notion "the polluter pays principle"
- The operator or occupier of a Common Biomedical Waste Treatment Facility (CBMWTF) is held legally liable for any environmental damage or harm to the public caused by improper handling of biomedical waste. This emphasizes the importance of adhering to stringent safety protocols during treatment and disposal processes
- The proper handling and disposal of biomedical waste is a statutory requirement for hospital administrators. This means adhering to regulations is not just good practice, but a legal obligation. Hospital administrators must ensure that waste generated within their facilities is managed without posing any adverse effects on human health or the environment
- For non-compliant hospitals, the CPCB or SPCBs may revoke their consent to operate. This essentially shuts down the facility's ability to function until they can demonstrate adherence to regulations
- In severe cases, the authorization of non-compliant healthcare institutions could be revoked, significantly impacting their ability to operate legally
- Failure to comply with the regulations may also lead to punitive actions under the Environment (Protection) Act, 1986. This could include imprisonment for up to 5 years, a fine of Rs. 1 lakh (100,000 rupees), or both

Effective implementation of the biomedical waste management pivots on orientation, training and involvement of all the staff in the facility. Ensuring proper disposal and segregation at source is the most important step as this is the limiting factor for most organizations. Continuous training and committees to monitor the implementation can be of help.

STP plant in Hospitals[3, 6, 8-10]

In accordance with the 2016 Biomedical Waste Management and Handling Rules, functional Sewage Treatment Plants (STPs) are now a prerequisite for hospital authorization. This revision establishes a linkage between these regulations and water and air pollution control acts, fostering a more comprehensive environmental management approach. This shift in focus yields a twofold benefit: streamlined administration through a five-year consent validity period for compliant hospitals, and a heightened emphasis on hospital administrator responsibility for ensuring STP functionality. However, this emphasis on STPs unveils a potential knowledge gap, as some hospitals may lack compliant STP infrastructure despite possessing efficient biomedical waste management practices. To bridge this potential discrepancy, hospitals can either invest in the construction of compliant STPs or seek the guidance of qualified wastewater treatment specialists to guarantee that their existing systems adhere to regulatory requirements. Through a comprehensive understanding of the crucial role played by STPs and the implementation of proactive measures to address any shortcomings, hospital administrators can ensure their facilities operate in strict accordance with the latest regulations, thereby contributing to the responsible protection of the environment.

Studies across the globe paint a concerning picture of widespread deficiencies in sewage treatment infrastructure. In Venezuela, a staggering 97% of sewage is discharged directly into the environment, highlighting a complete absence of treatment systems. Sub-Saharan Africa faces a similar challenge, lacking the necessary infrastructure for wastewater treatment altogether. Even in regions with moderate development, like Iran, untreated sewage contaminates groundwater resources.

Research examining a household wastewater treatment plant in Erzincan City, presumably located in a moderately developed region, further underscores the issue. This analysis revealed that only 15% of collected wastewater undergoes any form of treatment, and even that treatment may vary significantly in effectiveness. The study compared five different treatment methods employed at the plant, including conventional activated sludge, extended aeration, rotary biodisc reactors, and a peat bed reactor. While conventional activated sludge and biodisc technologies achieved the best results, the overall treatment efficacy remains concerning.

India presents another stark example, with severe water pollution caused by untreated sewage. Rivers like the Ganges and Yamuna bear the brunt of this environmental neglect, with an estimated 80% of the country's sewage released without treatment. Sewage treatment processes themselves are not inherently complex, often relying on microorganisms to break down pollutants and convert wastewater into cleaner water while generating solid biomass. However, the lack of investment in infrastructure and proper management practices across the globe significantly hinders progress towards responsible wastewater management.[12]

A sewage treatment plant:

- Effective sewage treatment plants achieve the desired water quality results consistently and reliably over extended periods
- Well-designed and constructed sewage treatment plants exhibit robustness and reliability, with minimal need for major repairs for at least 10-15 years of operation
- These plants require minimal input of money, energy, and chemicals to achieve the desired level of treated water quality. This translates to significant operational cost savings
- Sewage treatment plants are designed for ease of operation and maintenance, minimizing the burden on skilled personnel
- The cost of treating wastewater using a sewage treatment plant typically falls within the range of 20-30 per kL (excluding capital costs). This represents a cost savings of 50-70% compared to purchasing fresh water
- The treatment process has minimal impact on water quality parameters like pH, which remains relatively constant between 6.5-7.5 in both treated and untreated water
- Sewage treatment plants effectively remove pollutants such as Biochemical Oxygen Demand (BOD), typically reducing levels from 200-250 mg/L to less than 10 mg/L. Additionally, turbidity is significantly reduced to below 10 NTU
- Effective sewage treatment processes eliminate harmful bacteria like Escherichia coli from the treated water

Features of STP[11-14]

Sewage Treatment Plants (STPs) typically share common features in their designs, with various components serving specific functions: (Table 11.1)

Table 11.1: Component Chambers of STP

Bar Screen Chamber	The purpose of the bar screen is to prevent larger solid particles like plastic cups, paper dishes, polythene bags, condoms, and sanitary napkins from entering the STP
Oil and Grease/Grit Trap	The wastewater treatment process typically begins with a trap. This strategically placed device captures solid waste and fatty substances at the source, preventing them from entering the downstream treatment stages. Once captured, these materials are removed for proper disposal. The pretreated wastewater then flows from the trap to the equalization tank
Equalization Tank	This tank acts as a buffer, collecting raw sewage with potentially fluctuating flow rates. By storing and homogenizing the influent, the equalization tank ensures a consistent and manageable flow rate for the downstream treatment units within the Sewage Treatment Plant (STP)
Raw Sewage Lift Pumps	In small STPs rated below 5,000 m^3/day, these pumps are used to lift sewage to the aeration tank, avoiding the need for deep excavations due to gravity
Aeration Tank	This tank functions as a primary habitat for a dense population of microorganisms, collectively referred to as Mixed Liquor Suspended Solids (MLSS). These microbes play a vital role in the biodegradation of organic pollutants within the wastewater. To maintain optimal performance, the mixed liquor is constantly circulated and aerated within the tank. Following this biological treatment stage, the mixed liquor is transferred to the clarifier tank
Secondary Clarifier/ Settling Tank	They facilitate the separation of biological sludge, microbial flocs, and remaining suspended solids from the treated wastewater. This is integral to the biological treatment of sewage, where microorganisms aid in the breakdown of organic contaminants. Secondary clarifiers ensure the efficient removal of these microorganisms, allowing the clarified effluent to meet stringent quality standards before discharge
Clarified Water Sump	This sump collects overflow water from the clarifier, acting as a buffer between the secondary and tertiary treatment stages. The water quality here is suitable for garden use with proper disinfection
Filter Feed Pumps (FFP)	These pumps transfer water from the clarified water sump through the pressure sand filter (PSF) and activated carbon filter (ACF) installed in series
Pressure Sand Filter (PSF)	The PSF acts as a tertiary treatment unit, capturing trace amounts of solids that may escape the clarifier and handling up to 50 mg/L of solids efficiently
Activated Carbon Filter	Similar to the PSF, the ACF is a tertiary treatment unit that further improves water quality parameters such as BOD, COD, turbidity, color, and odor after the water has passed through the PSF
Disinfection of Treated Water	Treated water undergoes disinfection to eliminate disease-causing organisms, including bacteria and viruses. Common methods include chlorination, ozonation, and UV radiation
Excess Sludge Handling	Biological treatment generates excess biological solids due to microorganism growth. This excess biomass undergoes a five-step process: removal, storage, conditioning, dewatering, and disposal

Parameter Typical Range Remarks[11, 15]

- Food-to-mass (F/M) ratio: 0.05–0.30
- Oxygen requirement: 1.0–1.8 kg/kg BOD
- Excess sludge: 0.1–0.25 kg/kg BOD
- Efficiency: 70–95% (Fig. 11.6)

BMW management during the COVID-19 pandemic [8, 15]

COVID-19 has posed formidable challenges to healthcare facilities, including overwhelming biomedical waste management. Guidelines have rapidly changed and been modified in line with the mounting pressure of waste generation. Double bagging of generated waste was recommended in the BMW guidelines released for management of COVID-19 waste. The following salient changes were also implemented in BMW management in healthcare facilities to tackle the growing burden of high waste generation and scrupulous need for maintaining sustained infection control.

- Double Bagging: Double bagging of waste became a recommended practice as per the revised BMW guidelines for managing COVID-19 waste. This additional layer of containment helps minimize the risk of exposure to infectious materials
- Enhanced Personnel Practices: Dedicated staff equipped with appropriate Personal Protective Equipment (PPE) and comprehensive training were deployed for waste collection using designated trolleys. This ensures proper handling procedures and minimizes risks for healthcare personnel
- Segregated Transport: Dedicated routes, both vertical and horizontal within healthcare facilities, were established for the safe transport of COVID-19 waste
- Specialized Transport Vehicles: Dedicated trucks with clear labeling were employed to transport COVID-19 waste to Common Bio-medical Waste Treatment Facilities (CBWTFs). This segregation helps prevent contamination of other waste streams
- Continuous Training and Awareness: Regular training and awareness sessions were implemented to ensure healthcare workers handling BMW possess the most up-to-date knowledge, skills, and safety protocols
- Data-Driven Monitoring: Rigorous monitoring of waste generation data using mobile applications allows for informed decision-making and resource allocation for BMWM activities

Evidence from Systematic Review[16-28]

The recent studies on Biomedical Waste (BMW) Management during the COVID-19 pandemic emphasize the importance of innovative approaches to handling increased waste, especially from healthcare settings. Enhanced treatment techniques for BMW, such as plasma pyrolysis and alkaline hydrolysis, are identified as potential solutions. Several studies highlighted the importance of better segregation, smart collection methods like IoT-based bio-bins, and the potential of re-utilizing treated BMW in various applications. Concerning hospital wastewater, advanced treatment methods like AOPs were recognized as essential in ensuring public health and environmental safety.[18] In India, the situation underscored a need to upscale their waste treatment capacity and integrate artificial intelligence for more efficient waste processing. As for the vast amounts of PPE generated, sustainable recycling methods were deemed necessary, with decontamination techniques like vaporised H2O2 and moist heating being potent for PPE reuse.[21, 22] Furthermore, there was a noted significance in understanding challenges related to the acceptance of re-used PPE among healthcare workers.[22]

The studies on biomedical waste management during the COVID-19 pandemic emphasize a range of innovative solutions and highlight gaps in current practices across various countries. Disinfection of waste using chlorine solutions and double bagging is a recommended practice, with mobile incineration and designated transport vehicles offering promising avenues for waste management.[23] India's specific challenges include a high prevalence of open dumping in hospitals, inadequate incineration facilities, and poor awareness among staff.[24, 25] Innovative solutions in India range from portable ventilator designs to technologies like “Brick 2.0” made from recycled PPE face masks and advanced wastewater treatment using nano-adsorbents. Global practices during the pandemic also focused on advanced disinfection techniques like vaporized hydrogen peroxide and ultraviolet germicidal irradiation for sterilizing PPE.[26] The significance of systematic management of biomedical waste, such as mask and PPE disposal guidelines, is further underscored, with emphasis on recycling and reprocessing to mitigate environmental impacts.[27, 28] Meanwhile, Bangladesh's vaccination-related waste management was notable for its excellent segregation but faced challenges in handling and disposal, suggesting potential reuse of vaccine vials in infrastructure projects.[29] In sum, while there have been advancements in waste management strategies during the COVID-19 pandemic, gaps persist, necessitating a combined focus on innovative solutions, increased awareness, and infrastructure development.

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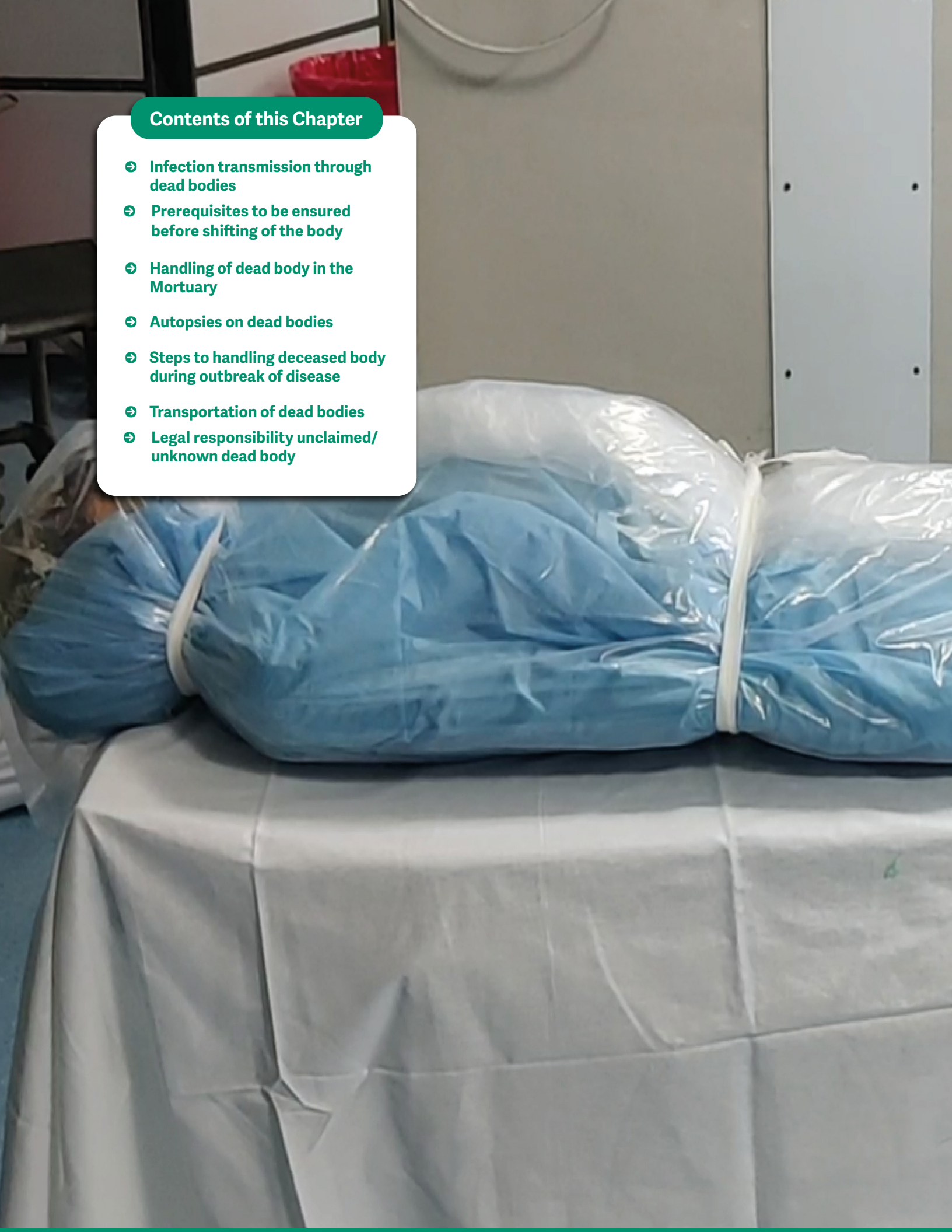

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- Prerequisites to be ensured before shifting of the body
- Handling of dead body in the Mortuary
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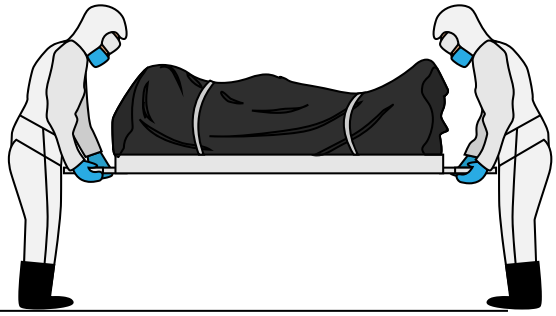
- Steps to handling deceased body during outbreak of disease
- Transportation of dead bodies
- Legal responsibility unclaimed/ unknown dead body

Chapter 12

Handling of the Deceased

Picture Credit: AIIMS, New Delhi

Handling of the Deceased



Infection transmission through dead bodies

Public health emergencies have often stemmed from highly contagious diseases like COVID-19, Plague, Cholera, Typhoid fever, Tuberculosis, Anthrax, Smallpox, and Influenza. While these illnesses are easily transmitted during infection, the causative agents typically do not persist long in the body after death. Therefore, the risk of contracting these diseases from deceased individuals is generally low.[1] There is a little evidence that transmission of pathogens from deceased individuals can occur. Diseases like COVID-19, tuberculosis, and influenza primarily spread through droplets from coughs or sneezes of living individuals. However, the risk of transmission from a deceased person is notably lower since they can't produce these droplets. Still, during post-mortem activities, aerosols might be released, presenting a potential hazard. It's important to note that the risk of transmission for certain bloodborne pathogens, including HIV, hepatitis B, and hepatitis C, can persist even after death through direct contact with infected blood.[2]

All healthcare workers (HCWs) designated to handle deceased patients must undergo thorough training in infection prevention and control (IPC) practices. This training should encompass standard precautions, including rigorous hand hygiene appropriate personal protective equipment (PPE) usage, safe sharps handling and meticulous disinfection of all the surfaces including disinfecting the housing of the deceased patient, disinfecting instruments and devices used during patient care, disinfecting linens used with the patient, and disinfecting environmental surfaces in the patient care area. 1% sodium hypochlorite solution is the recommended disinfectant for these surfaces. After application, allow a contact time of 15-20 minutes for effective disinfection, followed by air drying.[3]

Prerequisites before shifting of the body[3, 4]:

- Strict adherence to proper hand hygiene and the appropriate use of personal protective equipment (PPE) is essential. This includes water-resistant aprons, goggles, N95 respirators, and gloves
- Following the removal of any tubes, drains, or catheters, meticulous disinfection is required for the puncture sites or wounds with a 1% sodium hypochlorite solution. These areas should then be dressed with impermeable material
- To prevent the leakage of bodily fluids, the oral and nasal orifices of the deceased must be plugged securely
- The body should be placed in a leak-proof plastic bag with a minimum thickness of 150 microns. For additional precaution, the exterior surface of the body bag can be disinfected with a 1% sodium hypochlorite solution
- Soiled linen used during the process must be handled following standard precautions for biohazardous waste. This involves placing them in a biohazard bag and disinfecting the outer surface of the bag with a 1% sodium hypochlorite solution

Handling of dead body in the Mortuary[3, 4]:

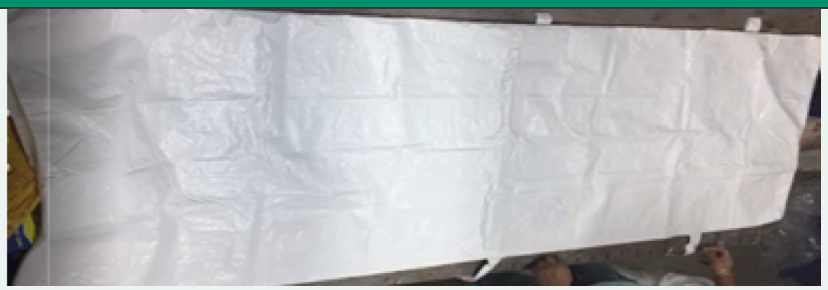
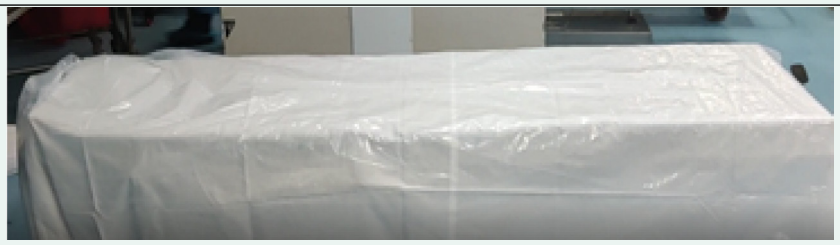
- Mortuary staff should rigorously adhere to universal precautions at all times
- Deceased bodies should be stored in designated cold storage chambers maintained at a constant temperature of approximately 4°C (39°F)
- Environmental surfaces within the chamber, instruments used during handling, and transport trolleys must be meticulously disinfected using a 1% sodium hypochlorite solution
- Following the removal of a body, meticulous cleaning and disinfection procedures must be implemented. This includes thorough cleaning of the chamber door, handles, and floor using a fresh 1% sodium hypochlorite solution
- Embalming should be avoided whenever possible to minimize the risk of infectious agent transmission. If unavoidable due to exceptional circumstances, minimally invasive techniques are highly recommended to reduce the risk of exposure to bodily fluids

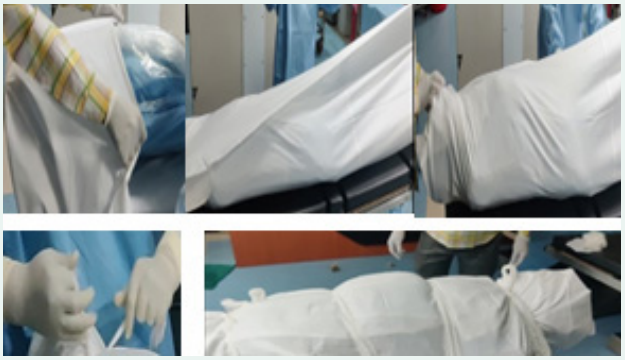
Autopsies on dead bodies[3, 4]

Autopsies should be avoided, however, when deemed essential, autopsies should be conducted while adhering to rigorous infection control protocols to minimize the risk of exposure to pathogens. These protocols include:

- The autopsy room should only accommodate essential personnel, including a restricted number of forensic experts and support staff
- A full complement of PPE, including gowns, gloves, eye protection, and respiratory protection as per risk assessment, must be worn by all personnel throughout the procedure
- To minimize the risk of sharps injuries, round-ended scissors and heavy-duty blades with blunted points should be used whenever possible
- Dissection should be performed cautiously, focusing on one body cavity at a time
- Unfixed organs should be stabilized on the dissection table and sliced with a sponge to protect the hands
- The autopsy room should be maintained under negative pressure to prevent airborne contaminants from escaping
- Needles must never be re-sheathed after fluid sampling. Both needles and syringes should be disposed off promptly in designated sharps containers
- Techniques to minimize aerosol generation, particularly when handling lung tissue, should be prioritized
- Following the autopsy, the body should be thoroughly disinfected with a 1% sodium hypochlorite solution. Subsequently, the body should be placed in a leak-proof body bag, ensuring its exterior is disinfected as well with the same disinfectant

Table 12.1: Steps for handling deceased body during Outbreak of disease[4]

S. No.	Steps	Illustrative view
1.	Place the unzipped body bag duly expanded on the stretcher Note: If the body bag has a central zip, then it should be used in the last step before shifting out the body	
2.	Place a white shroud/ sheet duly expanded on the stretcher	
3.	Put a thick polythene sheet over this white sheet	
4.	Pull the body from the bed to the stretcher using corners of bed sheet on this plastic sheet	
5.	Wrapping of the polythene sheet over the body by raising both sides up, bringing them to the center and folding downward centrally in such a way that the entire body is wrapped and prevents spillage of any fluid. Flap on lower (feet side) folded up towards lower leg and of upper (head side) down towards face/neck. Tie the sheet at the three ends- head, face and legs	

S. No.	Steps	Illustrative view
6.	Now wrap white sheet. Loose ends of sheet at both upper (Head side) and lower ends (feet side) are folded over face/neck and lower leg region Use bandage to tighten at the level of chest-abdominal wall junction Tie sheet at head (Vertex) end and feet end using bandage	
7.	Label the body. (name, age, sex, UHID/Reg., number, date of admission, status of the disease, date of death etc.)	
8.	Secure the deceased individual to a specifically designed, leak-proof body bag and then transport the body out of the patient care area (Please also see Step 1)	
9.	Spray 1% hypochlorite solution over the exterior of the body bag	

Transportation[3, 4]

A. By Road

- Road transportation is done through hearse van having a portable cold chamber where the temperature of the chamber is maintained at 4 to 8°C and the duration without embalming is safe within 24 to 72 hours
- Body packing during transportation:
  - The body should be tightly wrapped in a plastic sheet and then packed in a leak proof double body bag
  - The body bag should not be opened and no religious rituals should be performed in between or at the venue
  - The body handlers should wear PPE like coverall, N95 masks, nitrile gloves, shoe covers and head covers while loading and unloading
  - Following the transfer of the deceased to cremation or burial, the vehicle must undergo a thorough decontamination process using a 1% sodium hypochlorite solution

B. Air transport of COVID-19/ any unknown infectious etiology death of a Patient:

In exceptional situations, authorities may recommend the implementation of safe embalming practices by qualified higher medical facilities.

At the Crematorium/ Burial Ground[3, 4]

- Crematorium/burial staff should be sensitized that standard protocols are sufficient as COVID-19 poses no additional risk during these procedures
- Staff should adhere to established standard practices for hand hygiene, wearing masks and gloves
- Viewing of the deceased may be permitted under controlled circumstances. Family members may briefly view the deceased with the head end of the body bag unzipped by staff in PPE and standard precautions
- Religious practices that do not involve direct physical contact with the body, such as reading scriptures or sprinkling holy water, may be allowed as per local customs
- Practices involving physical contact with the body, such as bathing, kissing, or hugging, are strictly discouraged to minimize the risk of transmission
- In cases of high mortality rates, both cremation and burial are acceptable methods for safe disposal of the deceased. However, the final decision regarding the preferred method should be made by local authorities considering public health interests
- For burials, the gravesite should be cemented and marked appropriately
- Proper hand hygiene is essential for both funeral/burial staff and family members following cremation or burial procedures
- Cremated ashes pose no contagious risk and can be collected for final rituals according to religious or cultural traditions
- Minimize gatherings at crematoriums and burial grounds. This social distancing measure is crucial to protect public health, as some mourners may be unknowingly infected and are contagious

Legal responsibility of Unclaimed/ Unknown or the family members are not in position to collect the dead bodies of positive or suspected deaths[3, 4]

In some cases, social stigma surrounding death or illness may prevent families from claiming the body of a deceased one. In many cases, relatives may be unable to be present due to health limitations, geographical distance, or transportation difficulties. In such cases, the hospital, in consultation with local law enforcement and administrative authorities, may proceed with respectful disposition of the remains after obtaining informed consent from the deceased's family.

Evidence from systematic review [5, 6]

Due to the highly contagious nature of COVID-19, proper precautions are essential for personnel handling the deceased. Rigorous protocols must be implemented at every stage of the disposal process to minimize the risk of transmission to staff involved. In this regard, some important considerations that were drawn from the systematic review are listed below:

- Planning: Raising public awareness about safe handling practices for deceased individuals is crucial to address social stigma and promote respectful practices. Developing and implementing a preparedness and information management plan is crucial. This plan should clearly define roles and responsibilities for various stakeholders involved in handling unclaimed remains and ensure the availability of essential resources such as proper transportation, equipment, and designated facilities are available
- Vaccination: It is crucial to identify key professional groups within and beyond the healthcare system who will be responsible for handling the remains of deceased individuals. Vaccination of all who handle cadavers is an important precaution that should not be missed

➲ Embalming and Autopsy:

- For suspected COVID-19 cases during pandemic, prioritizing external examinations and diagnostic tests over autopsies can safeguard healthcare workers and minimize the risk of exposure. Incorporating radiological methods like X-rays and CT scans can significantly support the diagnostic process
- Formalin-fixed and Formalin-fixed paraffin-embedded (FFPE) tissue samples obtained during autopsies can be used for definitive postmortem diagnosis of COVID-19 infection, following established safety protocols
- Whenever feasible, autopsy and embalming procedures should prioritize techniques that minimize the generation of aerosols. If unavoidable, appropriate suction devices to minimalize aerosol spread should be used
- While an autopsy room meeting Biosafety Level 3 (BSL-3) standards is the optimal configuration, it is not a mandatory requirement always
- Containment devices (like Bio-safety cabinets) should be used when handling small specimens of infected dead bodies, during an autopsy

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Contents of this Chapter

Picture Credit: AIIMS, New Delhi

Chapter 13

Management of Disease Outbreaks

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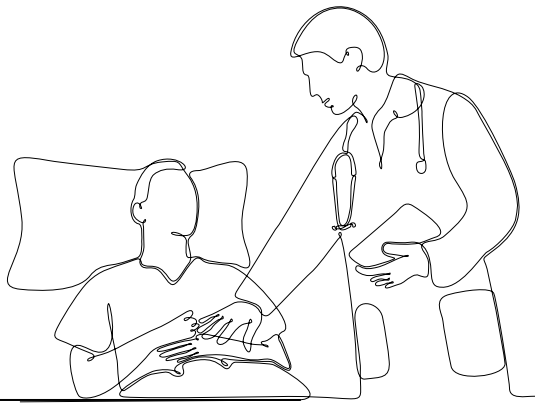


A disease outbreak signifies a surge in cases beyond what's typically expected within a specific community, geographical area, or season. These occurrences are often driven by infectious agents transmitted through various routes: direct person-to-person contact, exposure to animal reservoirs or environmental sources, or by insect/animal vectors. Human behavior also plays a significant role in disease spread. Early detection and reporting of outbreaks are paramount to minimizing their negative social and economic consequences.[1] The status of an outbreak is relative to the usual frequency of the disease in the same area, among the same population, at the same season of the year. [2]

Levels of Occurrence:[3]

Depending on the spread and rate of new cases of infectious diseases, the various levels of occurrence can be classified into four types as follows (figure 13.1):

Figure 13.1 Levels of Occurence of infectious diseases

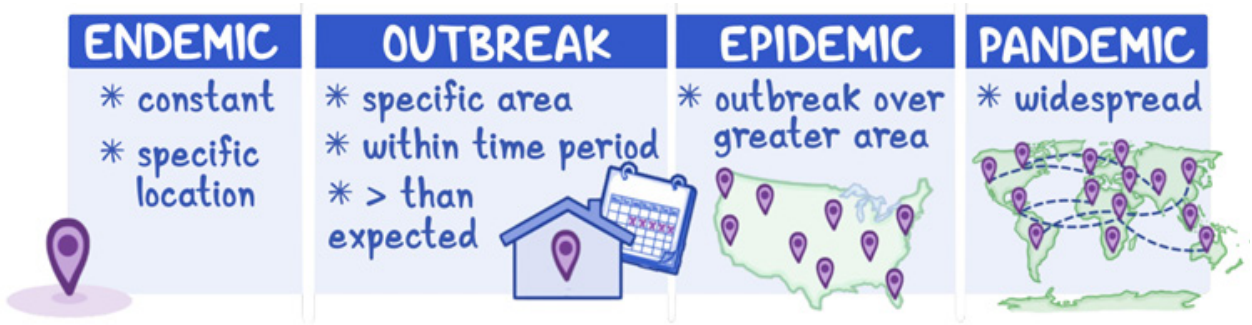


Table 13.1: Some important definitions[3-5]

Incubation period	A period of subclinical or inapparent pathologic changes following exposure, ending with the onset of symptoms of infectious disease
Endemic	The constant amount of a specific disease that is usually present in a geographic location, like a state or country
Outbreak	A higher number of cases than expected in an area within a certain time period
Epidemic	Similar to an outbreak, but with a larger number of cases or occurring over a greater area or both
Pandemic	Similar to epidemic, but has spread over several countries or continents, usually affecting a large number of people

Types of outbreaks [6]

- Community-acquired infections (CAIs): Infections contracted outside of a healthcare setting. Examples include foodborne illnesses, measles, and the common cold
- Healthcare-associated infections (HAIs): Infections which develop in patients while receiving healthcare or shortly after discharge

Identification of Outbreaks: [7]

Observed vs. expected:

Effectively identifying disease outbreaks hinges on the ability to detect a significant increase in illness rates compared to what's normally expected. Therefore, establishing a "baseline level of illness" is crucial for outbreak detection.

The most reliable way to define the baseline is by analyzing historical data from previous years. This data reveals the typical number of illness cases expected within a specific region over a defined timeframe, typically per year or season. These baseline illnesses are usually sporadic, meaning they occur independently and are not linked to a common source.

Many illnesses exhibit a seasonal pattern, with case numbers fluctuating throughout the year. Understanding these seasonal trends within the historical data allows for a more accurate baseline definition and facilitates the timely identification of potential outbreaks that deviate from this expected pattern.

Information sources:

There are several sources of information you can use to help identify outbreaks.

- **Surveillance systems:** Dedicated programs routinely track and store data on illness occurrences within a defined region. This historical data serves as a baseline, allowing for the identification of potential outbreaks by comparing current illness rates to established expectations
- **Public Health Networks:** Collaboration with regional, territorial investigators, and food safety partners plays a vital role. Notifications of illness clusters or ongoing investigations from these partners can provide valuable clues about potential outbreaks and exposures to monitor
- **Public Reporting:** Direct reporting of illness and suspected exposures by the public can be particularly helpful in identifying foodborne illness clusters. Additionally, monitoring news reports and social media can be another valuable tool for identifying potential outbreaks
- **Health Providers:** Frontline healthcare providers are often the first to observe an unusual increase in illness within their patient population. Prompt communication with public health authorities by these professionals allows for a faster and more effective response

Causes of Outbreaks: [8]

There are many causes of outbreaks, four common ones are:

- **Travel to Endemic Areas:** Susceptible individuals traveling to regions where an infectious disease is prevalent (endemic) can become infected and introduce the disease upon returning to their communities. Understanding the concept of "incidence rate" is crucial in this context. Incidence rate refers to the frequency of new illness cases within a population over a specific timeframe. By monitoring incidence rates, public health officials can identify potential outbreaks arising from travel-related exposures
- **Imported Cases and Environmental Contamination:** Travel or movement of infected humans or animals from endemic areas can introduce the disease into a susceptible population where it wasn't previously established (non-endemic). Similarly, contamination of food, water, or other environmental sources with an

infectious agent not typically present can also trigger an outbreak. For instance, a bioterrorism attack involving anthrax spores in the mail could cause an outbreak

- **Social and Behavioral Shifts:** The emergence of new or unusual social, behavioral, sexual, or cultural practices can sometimes lead to outbreaks in settings with low endemicity (low prevalence) of a particular disease. Mass population movements, such as refugee migrations during wartime or pilgrimages to religious sites, can create conditions conducive for disease spread
- **Changes in Host Susceptibility:** Modifications in host susceptibility and immune response, either through natural causes or drug-induced immunosuppression, can increase the risk of outbreaks. Examples of immunosuppression include conditions like cancer, malnutrition, or diseases such as HIV/AIDS that weaken the immune system

Healthcare environments pose a distinct challenge for outbreak control due to the confluence of susceptible individuals and potential sources of contamination. HAI outbreaks, those originating within healthcare facilities, can be propagated through various well-defined transmission modes:

1. Common Source Transmission: This mode of transmission involves a single, contaminated source that infects multiple patients or healthcare personnel. Examples include contaminated medical equipment, medications, food, or water supplies
2. Human Reservoir Transmission: Infected patients or healthcare workers can act as reservoirs, harboring and transmitting the pathogen directly or indirectly to others. This transmission can occur through close contact, contaminated hands, or fomites
3. Person-to-Person Transmission: Direct or indirect contact between infected and susceptible individuals is a frequent route of transmission. This can occur through close contact, contaminated hands, or respiratory droplets expelled during coughing, sneezing, or certain medical procedures
4. Airborne Transmission: Certain pathogens have the ability to transmit through airborne droplets or aerosols generated by coughing, sneezing, or medical procedures that aerosolize infectious material
5. Environmental Transmission (Fomite-Mediated or Device-Associated): Indirect transmission via contaminated surfaces (fomites) in the healthcare environment or the introduction of new medical devices can also contribute to outbreaks
6. Uncertain Mode of Transmission: During the initial stages of an outbreak investigation, the precise mode of transmission for a particular pathogen may remain unclear. However, a thorough investigation can often elucidate the transmission dynamics

Factors influencing the occurrence and spread of outbreaks:[9]

Major factors currently contributing to the increased prevalence of emerging and reemerging infectious disease outbreaks are as follows:

Demographic and Socioeconomic Shifts:

- Population growth, urbanization, and increased global travel all lead to increased human-to-human contact, facilitating the spread of pathogens. Denser housing conditions can also contribute to transmission
- Changes in human behavior, such as alterations in sexual practices or childcare arrangements, can influence disease transmission patterns

Environmental Changes:

- Global climate change, deforestation, and land-use modifications can disrupt ecosystems and create new opportunities for pathogen emergence and spread. Natural disasters like floods and droughts can further exacerbate these effects

Changes in Healthcare Practices:

- Modern medicine, particularly in developed countries, allows individuals with chronic infectious diseases to live longer, potentially acting as reservoirs for transmission
- Enhanced diagnostic tools, such as molecular methods, enable the detection of previously unknown or uncultivable pathogens, potentially revealing new threats

Microbial Evolution and Adaptation:

- Microorganisms naturally evolve and adapt to survive in changing environments. This can lead to the emergence of new strains or increased antimicrobial resistance in existing pathogens

Public Health Challenges:

- Inadequate funding and infrastructure within public health systems can hinder outbreak preparedness and response efforts
- Increased global mobility due to travel and migration can complicate disease control efforts
- Bioterrorism remains a potential threat, requiring robust public health surveillance and preparedness measures

Patterns of transmission and spread within populations:

Objectives of Outbreak Management: [2, 10]

The objectives of outbreak management of communicable diseases focus on interruption of transmission as quickly as possible to prevent further cases. They are:

- Outbreak Definition and Magnitude: The initial phase involves defining the outbreak in terms of time, location, and the number of people affected. This helps assess the overall scope and urgency of the situation
- Etiological Investigation: Determining the causative agent or factors responsible for the outbreak is crucial. This may involve analyzing clinical data, laboratory testing, and environmental sampling
- Outbreak Confirmation and Notification: Once a suspected outbreak is confirmed, prompt notification to public health authorities is essential to initiate a coordinated response
- Case Identification and Data Collection: Active case finding and meticulous data collection regarding case demographics, symptoms, and potential exposures are critical steps for characterizing the outbreak
- Infection Control Measures: Implementing effective infection control measures to prevent further transmission is paramount. This may involve isolation, quarantine, vaccination (if available), and disinfection protocols
- Source Identification and Control: Identifying the source(s) of infection, along with the mode(s) of transmission, is vital for interrupting the outbreak chain and preventing future occurrences

- Communication and Education: Effective communication with healthcare providers, the public, and the media is crucial to raise awareness, encourage preventive behaviors, and manage public anxieties
- Outbreak Debriefing and Recommendations: Following the outbreak, a thorough debriefing is essential to analyze the response efforts, identify areas for improvement, and develop recommendations to prevent similar outbreaks in the future

To determine the appropriate response to a potential outbreak, public health officials conduct a risk assessment that considers a multitude of factors. Some factors for consideration include:

- The severity of the illness
- The number of cases
- The source
- Mode or ease of transmission
- The availability of prevention and control measures

Investigation Tools: [11–14]

Infectious Disease Surveillance: Infectious disease surveillance is an important epidemiological tool used to describe the disease burden, monitor disease trends, control eliminate and eradicate diseases. Several types of surveillance methods are used to this end and have critically different approaches enhance the effectiveness to capture relevant data. Some of them are given below:

1. Active and Passive Surveillance
2. Case based Surveillance
3. Aggregated Surveillance
4. Population based Surveillance
5. Sentinel Surveillance
6. Syndromic Surveillance
7. Zoonotic Surveillance
8. Serosurveillance

Line List:

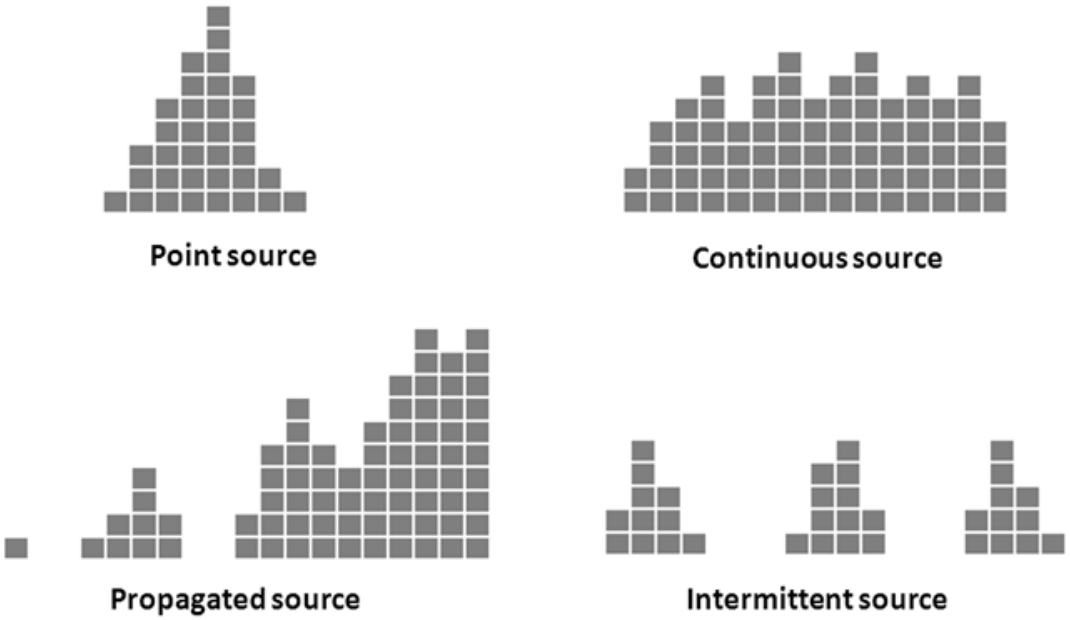
Line lists are a fundamental tool in outbreak investigations, serving to summarize key information about each identified case. These tables function essentially as databases, with each row representing a unique case and each column containing a specific variable. These variables typically encompass demographic details, clinical information (symptoms, diagnoses), and epidemiological data related to potential risk factors and exposures.

Table 13.2: Data typically collated in a Line List

Item	Description
CaseID	Unique identifier assigned to each case-patient for this investigation
Case initials	Case patient initials or name
Age	Age in years
Sex	Male, Female or Unknown
Onset date	Date of symptom onset, DD/MM/YY
Current status	Outpatient, Inpatient, Inpatient ICU, Discharged, Died
Location	Hospital, City/Locality, State
Case category	Confirmed, probable, suspect
Epi Links	Known exposures, affiliations or connections to other cases

Underlying conditions	Significant immunodeficiencies, medications or other conditions that may alter the patient's susceptibility or course
Chest x-ray	Was a chest x-ray performed? If so, what were the results?
Specimens collected	e.g.: Nasopharyngeal swab, nasopharyngeal wash/aspirate, oropharyngeal swab, sputum, tracheal aspirate, bronchoalveolar lavage, pleural fluid, lung tissue, blood, serum, urine
Testing requested	e.g.: Culture, antigen detection, antibody/serology, polymerase chain reaction, immunohistochemistry
Results	Findings of laboratory testing to date

Figure 13.2 Epidemic Curve-Modes of Transmission of Infection



The Power of Line Lists:

Line lists offer a comprehensive perspective on an outbreak by capturing critical details about people, places, and times associated with each case. They can be created either before or alongside another crucial tool: the hypothesis-generating questionnaire.

Benefits of a Well-Constructed Line List:

A well-designed line list serves several valuable purposes:

- Summarizes Known Information: It offers a consolidated view of the available data for each case, facilitating easier analysis
- Trend Identification: By analyzing the line list, investigators can readily identify emerging trends or patterns within the outbreak data
- Data Gap Detection: Missing information in the line list can highlight areas where further investigation is needed to complete the picture
- Error Detection: Inconsistencies within the data can be more easily spotted during line list review
- Descriptive Statistics: The line list serves as a valuable foundation for generating descriptive statistics that summarize the outbreak characteristics

- Epidemic Curve Construction: Data from the line list is often used to construct an epidemic curve, which visually depicts the outbreak's progression over time

Epidemic Curve:

An epidemic curve (epi curve) is a vital tool in outbreak investigations. This visual representation, akin to a bar chart (histogram), depicts the distribution of cases across a timeline. The x-axis (horizontal) represents time intervals, while the y-axis (vertical) displays the number of cases reported within each interval. Essentially, the epi curve offers a snapshot of illness onset for cases associated with the outbreak.

Insights from the Epi Curve:

Analysis of the epi curve yields valuable information about the outbreak, including:

- Outbreak Magnitude: The overall height of the curve reflects the total number of cases
- Transmission Pattern: The shape of the curve can provide clues about the mode of transmission, such as point-source, continuous common source, propagated source, or intermittent source (refer to Figure 13.2 for examples)
- Temporal Trends: The epi curve allows visualization of how the outbreak has progressed over time, including the initial rise, peak, and decline of cases
- Exposure Period: The timeframe encompassing the reported cases offers insights into the likely exposure period for the outbreak pathogen

The epi curve is a dynamic tool that should be continually updated as new cases are identified. By interpreting the shape and trends within the curve, public health investigators can gain valuable insights into the outbreak dynamics, facilitating the development of targeted control measures.

Decoding the Shape of an Epi Curve: The overall shape of an epi curve can offer valuable clues about the mode of transmission for an outbreak. Here's a breakdown of some common epi curve patterns and their associated transmission scenarios

i. **Point Source Outbreak:** This curve typically exhibits a sharp rise in cases to a peak, followed by a gradual decline. The majority of cases occur within a single incubation period of the disease. This pattern suggests a scenario where everyone was exposed to a common source over a brief timeframe, such as a single contaminated meal or a shared event

ii. **Continuous Common Source Outbreak:** In contrast to a point source, this curve displays a more extended outbreak period exceeding one incubation period. Cases are distributed over a broader timeframe, reflecting continuous exposure to the same contaminated source over a prolonged period (days, weeks, or longer). An example could be a contaminated water supply

iii. **Propagated Source Outbreak:** This curve is characterized by multiple peaks, often with some irregularity. These peaks represent successive "generations" of infection as the pathogen spreads from person to person (directly or indirectly through an intermediate host). The time between peaks is often roughly equivalent to the incubation period of the disease. Outbreaks due to person-to-person transmission of shigellosis often exhibit this pattern

iv. **Intermittent Source Outbreak:** Similar to a continuous common source outbreak, this curve shows multiple peaks. However, the timing of these peaks doesn't necessarily correspond to the incubation period. This suggests intermittent exposure to a contaminated source that reappears periodically. For instance, an outbreak

linked to a contaminated food product sold over time might exhibit this type of epi curve

Imperfect but Insightful: The Nuances of Epi Curves

While the previously described epi curve shapes offer valuable clues about outbreak transmission patterns, it's important to recognize that real-world outbreaks may not always perfectly align with these idealized models. The exact shape of an epi curve can be influenced by various factors, making a precise categorization sometimes challenging.

Despite these limitations, epi curves remain a powerful tool for public health professionals. Even an imperfect curve can provide valuable insights into the general pattern of spread within an outbreak. For instance, mixed outbreak patterns are not uncommon. These scenarios involve a combination of a common source exposure (e.g., contaminated food) followed by secondary person-to-person transmission, often within households. Foodborne pathogens like Norovirus, Hepatitis A, Shigella, and E. coli frequently exhibit this mixed pattern, reflected in the resulting epi curve.

Maps and spatial analysis tools:

Maps and spatial analysis have become invaluable tools in outbreak investigations. These techniques allow visualization of case locations, facilitating the identification of any spatial relationships between cases. This information can provide crucial clues about the outbreak source and its geographic spread over time.

Advanced Spatial Modeling:

While simple case location maps are a good starting point, various sophisticated spatial-transmission models can be employed for in-depth analysis. Examples include:

1. Patch or spatial metapopulation models
2. Distance-transmission models
3. Multigroup models
4. Network models
5. GIS: A Powerful Platform:

The widespread adoption of Geographic Information Systems (GIS) has revolutionized the way spatial data is analyzed in outbreak investigations. A GIS is essentially a specialized database designed to manage geographically referenced information. It provides a comprehensive suite of tools for data input, management, analysis, and visualization.

Applications of GIS in Outbreak Investigations:

Mapping Case Locations: The most basic application of GIS in outbreak investigations involves creating maps that display the geographical distribution of cases. These maps can be used to identify potential clusters of cases and visualize their proximity to potential sources or risk factors.

Engaging Data Presentation: Maps offer an engaging and easily understandable way to present complex data. They can visually depict geographical patterns, highlight outliers, and effectively communicate findings to a wider audience.

Case Visualization: GIS allows for plotting cases at their precise locations or aggregating them into defined administrative areas (e.g., counties, zip codes). These aggregations can be displayed as disease rates, providing a clearer picture of relative risk across different geographic areas.

Identifying Clusters: GIS facilitates the identification and analysis of disease clusters, defined as areas with higher-than-expected case concentrations. This information can serve as a crucial trigger for further investigation and can inform the development of targeted control measures

Integrated Disease Surveillance and Response (IDSR):

Developed by the World Health Organization (WHO) in 1998, the IDSR strategy aims to

strengthen public health surveillance by integrating data collection efforts across various levels of the healthcare system – from community clinics to national health agencies. This integrated approach offers several advantages:

- **Improved Data Quality:** By unifying surveillance systems across different levels, IDSR promotes consistency in data collection and reporting. This leads to more reliable and comprehensive data for disease monitoring and outbreak detection
- **Resource Efficiency:** IDSR emphasizes collecting only essential data needed for disease control activities. This reduces the burden on healthcare workers who often face time constraints. Additionally, focusing on aggregated data (data summarized over a specific area or population group) streamlines the data management process, leading to cost savings
- **Standardized Practices:** IDSR promotes the use of standardized case definitions and protocols across different healthcare settings. This consistency ensures that data collected at various levels is comparable and readily usable for analysis
- **Challenges of IDSR:** While IDSR offers significant benefits, there is a recognized challenge: achieving a balance between data efficiency and the need for detailed information. In certain situations, outbreak investigations may require more granular data than what is routinely collected through IDSR. Public health professionals need to find ways to supplement the core IDSR data with additional information when necessary to effectively target interventions during outbreaks

Global Outbreak Alert and Response Network (GOARN):

The World Health Organization (WHO) spearheads the Global Outbreak Alert and Response Network (GOARN), a powerful collaborative force for tackling international public health emergencies. This network brings together over 600 partners worldwide, encompassing a vast array of expertise:

- **Government Agencies:** National health ministries and public health institutions contribute their knowledge and resources to the network
- **Technical Institutions:** Leading research centers and laboratories provide critical scientific and technical support
- **Academic Institutions:** Universities and academic institutes offer valuable expertise in various disciplines relevant to outbreak response

GOARN's primary mission is to orchestrate a swift and effective response to outbreaks with international implications. This is achieved through:

Rapid Deployment: In the face of an outbreak, GOARN can rapidly deploy a multi-disciplinary team of experts to affected countries. This team typically comprises clinicians with hands-on experience in patient care, epidemiologists skilled in outbreak investigation, social mobilization specialists to engage communities, and communication experts to ensure clear and timely information dissemination.

GeoSentinel:

GeoSentinel is a global network of healthcare facilities with a unique mission: to monitor the health of travelers and migrants. These clinics play a vital role in identifying and recording cases of infectious diseases acquired during international travel. By serving as a centralized repository for such data, GeoSentinel offers invaluable insights for public health professionals:

- **Disease Movement Tracking:** GeoSentinel data allows for the analysis of how infectious diseases are spread across geographical borders. This information helps track the emergence and movement of new pathogens, as well as established infections in new areas.

- **Travel Medicine Guidance:** By identifying prevalent travel-related illnesses, GeoSentinel informs the development of evidence-based travel medicine guidelines. These guidelines equip healthcare providers with the knowledge to advise travelers on appropriate vaccinations, preventive measures, and potential health risks associated with specific destinations

Use of Bioinformatics: [15–17]

While the general public may sometimes be the first to notice potential outbreaks, translating these observations into actionable data for public health experts can be challenging. Language barriers, geographical separation, and knowledge gaps can hinder effective information gathering.

Bioinformatics offers a promising solution through the concept of "event ontology" for disease outbreaks. This structured framework allows for collecting and organizing information from diverse sources across a wider geographical area. By leveraging bioinformatics, we can transform unstructured natural language reports (e.g., news articles, social media posts) into a standardized format compatible with disease surveillance systems. This enables the inclusion of a broader range of data points in the early stages of outbreak detection.

Furthermore, bioinformatics holds immense potential for outbreak investigation. Advancements in rapid, high-throughput molecular profiling of microorganisms, coupled with text-mining techniques, opens exciting possibilities:

Pathogen History Reconstruction: By combining genetic data from the outbreak pathogen with geographical information, bioinformatics can help reconstruct the pathogen's history. This includes identifying its origin and tracing its migration routes, both regionally and internationally.

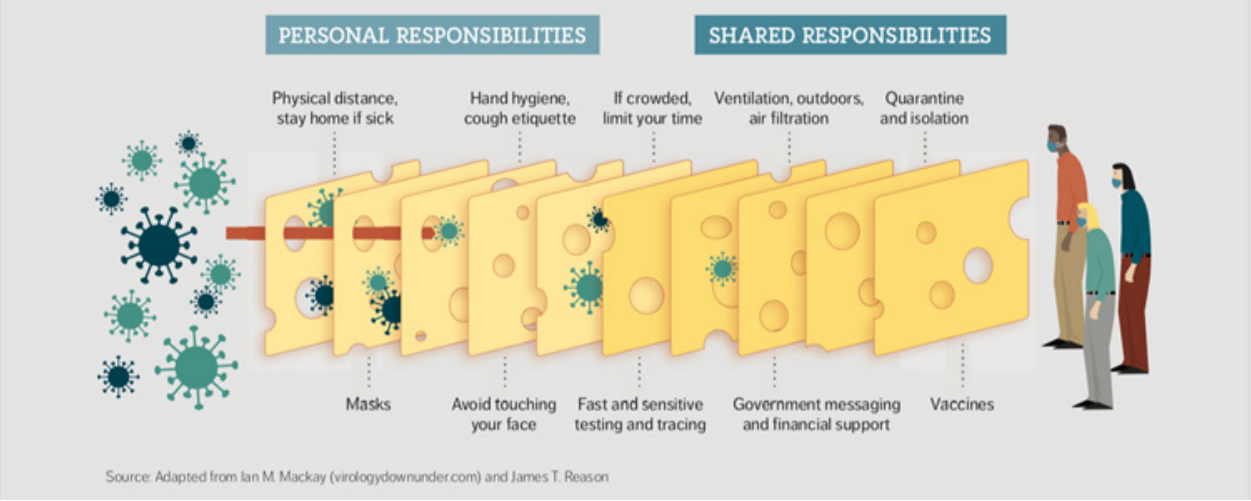
Identifying Transmission Routes: This enhanced understanding of a pathogen's movement can shed light on potential transmission routes within and between countries. This information is crucial for developing targeted intervention strategies to control the outbreak.

The Swiss Cheese Model: A Layered Approach to Disease Prevention [18,19]

Developed in the 1990s by James T. Reason and Rob Lee, the Swiss Cheese Model offers a powerful analogy for understanding infectious disease control. The model depicts multiple layers of preventive interventions, each represented by a slice of cheese.

Imperfect Slices:

Figure 13.3 The Swiss Cheese Model



No single intervention is foolproof. Each "slice" has inherent weaknesses or limitations, metaphorically illustrated by holes within the cheese. These holes can vary in size, number, and location, reflecting the dynamic nature of disease transmission and the effectiveness of interventions under different circumstances.

Layering for Defense:

The key strength of this model lies in the layering of multiple interventions. When implemented consistently and appropriately, the holes in one layer (intervention) can be effectively plugged by the strengths of another. This layered approach significantly reduces the risk of a complete alignment of holes across all slices, effectively preventing disease transmission.

Intervention Types:

Preventive interventions can be broadly categorized as personal (e.g., hand hygiene) or shared (e.g., public health campaigns). However, some interventions may encompass both aspects. The specific order of the slices doesn't necessarily reflect the effectiveness of each intervention, as transmission scenarios can be highly variable and complex.

External Influences:

The model also acknowledges external factors that can undermine or bolster prevention efforts. These factors are symbolized by the "black rats" nibbling on the cheese slices (negative influences) and the "extra cheese" (positive influences).

COVID-19 Application:

In the context of COVID-19, the Swiss Cheese Model emphasizes the value of combining multiple interventions, such as vaccination, masking, social distancing, and public health campaigns. The model highlights that transmission occurs only when holes in all the preventive layers happen to align simultaneously, creating a "pathway" for the virus.

Investigation of an Outbreak [20,21]

The emergence of an outbreak signals a disruption in the delicate balance between the infectious agent, the host population, and the surrounding environment. To effectively control the outbreak and prevent further spread, prompt and thorough investigation is essential. Epidemiology plays a pivotal role in this process.

Challenges of Outbreak Investigations:

While outbreak investigations share core principles with other epidemiological studies, they present unique challenges

- **Urgency:** When an outbreak is ongoing, the pressure to identify the source and prevent additional cases is immense. Time is of the essence to implement control measures and mitigate the public health impact
- **Limited Data:** Outbreaks often involve a relatively small number of initial cases, hindering the statistical power of the investigation. This can make it more difficult to draw definitive conclusions about the cause and risk factors
- **Media Bias:** Early media reports surrounding the outbreak can influence the responses of individuals subsequently interviewed during the investigation. This can lead to biased or inaccurate data collection
- **Competing Interests:** Concerns about legal liability or financial repercussions for individuals and institutions involved can create pressure to expedite the investigation, potentially leading to rushed conclusions about the outbreak source
- **Delayed Detection:** If the outbreak is not identified promptly, crucial clinical and environmental samples, which offer valuable clues about the cause, may become difficult or even impossible to obtain

Steps in management of disease outbreaks:[20-22]

Investigating an outbreak is desired to have an orderly procedure or practical guidelines as outlined below. Some of the steps can be done concurrently:

1. Verification of diagnosis
2. Establishing the background rate of disease and finding cases
3. Case definition
4. Defining the population at-risk
5. Rapid search for all cases and their characteristics
6. Descriptive Epidemiology
7. Data Analysis
8. Generating a hypothesis
9. Testing of Hypothesis
10. Evaluation of ecological factors
11. Further investigation of population at risk
12. Control measures
13. Interactions with the Public and Press

Figure 13.4 Infodemics during disease outbreaks

1. Verification of diagnosis:

In outbreak situations, ensuring accurate diagnoses quickly is paramount to prevent the spread of misinformation and guide effective interventions. Public health professionals prioritize rapid verification by strategically selecting a subset of cases for detailed clinical evaluation. Laboratory tests and medical records, when available, are then used to confirm these diagnoses. An iterative process of repeat testing and examinations may be employed for certain cases to ensure accuracy, ultimately refining the understanding of the outbreak and guiding control measures.

2. Establishing the background rate of disease and finding cases:

Confirming a suspected outbreak hinges on establishing the "usual" number of cases for the disease in the affected population. This background rate provides a benchmark for comparison. Several key steps are involved:

Defining "Normal": Public health officials need to quantify the typical number of cases expected for the disease within a specific timeframe (e.g., week, month) and geographical area. This often involves analyzing data from comparable seasons in previous years to account for seasonal variations.

Data Strength and Confirmation: The ease of establishing a background rate depends heavily on the availability of reliable diagnostic tests. For confirmed diseases with established tests, the process is more straightforward. In outbreaks of new diseases, however, substantial effort may be required to determine if past cases might have gone unrecognized.

Once data concerning the background rate has been collected and compared to the observed number of cases, it becomes possible to determine definitively whether a true outbreak is occurring or has occurred. Establishing the scope of the outbreak geographically and temporally (location and timeframe) can then be undertaken.

3. Case definition

Formulating a clear case definition is a vital step in any outbreak investigation. This definition establishes the criteria used to identify confirmed or probable cases. The complexity of this process can vary:

Straightforward Scenarios: For well-understood diseases with established diagnostic tests, defining a case definition can be relatively simple.

Challenges with New Diseases: Outbreaks involving new or poorly understood diseases pose a greater challenge. The unknown range of clinical symptoms can make it difficult to establish a precise case definition.

In some outbreak investigations, public health professionals may employ multiple case definitions. This allows for analysis of the data from different perspectives, potentially revealing a more comprehensive picture of the outbreak.

When conducting a case-control study (a type of epidemiological study) during an outbreak, researchers often prioritize a "strict" case definition. This approach aims to increase the specificity of the data, meaning it reduces the likelihood of misclassifying individuals as cases when they are not truly infected. However, this increased specificity may come at the cost of a smaller sample size, as fewer cases will meet the stricter definition

4. Defining the population at-risk

- A current, detailed map of the affected area is crucial for outbreak investigations
- Divide the area into manageable segments using natural landmarks as boundaries. These segments can be further subdivided for localized analysis
- Implement a system for assigning unique identifiers (e.g., numbers) to houses within each segment
- Establish the total population size. This data is essential for calculating attack rates (proportion of infected individuals) within different demographic groups later in the investigation

5. Rapid search for all cases and their characteristics

a. Medical Survey: Conduct a comprehensive survey within the defined area to identify all potential cases, including those without medical attention and those potentially exposed. Ideally, the survey should capture all individuals with symptoms or signs of the illness

b. Case Sheets: Develop a targeted case sheet (interview form) based on initial findings. This sheet should collect relevant information specific to the disease under investigation

c. Large Outbreaks: If case numbers are overwhelming, a random sample can be interviewed initially

d. Patient Contact Tracing: Ask patients about potentially infected individuals

in their surroundings with recent illness onset (within the incubation period of the disease)

e. Hospital Surveillance: Monitor hospital admissions for potential cases. This can reveal person-to-person transmission and identify additional cases

f. Continuing Search: Maintain ongoing case searching for secondary cases (new infections) every day until the outbreak is declared over. This period typically lasts twice the incubation period of the disease after the last case is identified

6. Descriptive Epidemiology

Case-finding activities, which involve collecting data from patients, are crucial for understanding an outbreak's epidemiology. By plotting the onset times of cases on an "epidemic curve" and analyzing patient characteristics, investigators can form hypotheses about the outbreak's source(s) and cause(s).

7. Data analysis:

Data analysis aims to uncover shared experiences within a group. It involves continuous examination of data categorized by time, location, and individuals involved (person). When the disease source is identified, this framework can be adapted to the Agent-Host-Environment model.

8. Generating a hypotheses

To control an outbreak and prevent future ones, we must pinpoint the source(s) of infection and how it's spreading. Analyzing data by time, place, and person (or using the Agent-Host-Environment model) helps us form hypotheses about:

a. The origin of the outbreak (source)

b. The germ or virus causing it (causative agent)

c. How it's being transmitted (modes of spread)

d. Any environmental factors aiding its spread

These hypotheses should be prioritized based on likelihood. The most likely scenario should guide further investigation. Additionally, existing data on similar outbreaks and the disease itself (epidemiologic, microbiologic, and veterinary) can provide valuable clues about potential sources and the agent's behavior.

9. Testing of hypotheses

Evaluate all potential causes (hypotheses) by comparing attack rates. This means looking at the percentage of people who got sick in groups exposed to a suspected factor compared to those who weren't exposed.

Next step: Design an analytic epidemiologic study to test the most likely hypothesis. There are different options beyond the common case-control study. Retrospective cohort and cross-sectional studies might be a better fit depending on the situation. All these approaches aim to uncover the link between a specific exposure and the outbreak's disease.

By analyzing the study results, epidemiologists can identify the hypothesis that best aligns with all the evidence. In challenging outbreaks, generating the right hypothesis might require multiple rounds of investigation. So, test one hypothesis, analyze the results, use those insights to refine other possibilities, and then design new studies to test them. This iterative approach helps pinpoint the true cause

10. Evaluation of environmental factors

To prevent the disease from spreading, investigators need to quickly understand what's happening. This involves:

Investigating the outbreak's origin: This includes environmental factors that might have played a role.

Conducting a case-control study: This compares people who have the disease with those who don't to identify potential causes.

A key goal is to link the disease to environmental factors. This helps us:

- Identify the source of the infection: Where did the outbreak begin?
- Find reservoirs: Where is the infectious agent living and multiplying?
- Understand transmission methods: How is the disease spreading from person to person or from the environment to people?
- Environmental samples are crucial for this investigation, but they can disappear quickly or be affected by interventions. So, collecting them as soon as possible is important

11. Further investigation of population at risk

A study of the population at risk or a sample of it may be needed to obtain additional information including medical examination, screening tests, examination of suspected food, faeces or blood samples, assessment of immunity status, etc. The approach may be retrospective or prospective. Healthy individuals (those who are not ill) from the same universe may be studied in a case control fashion. This will permit classification of all members as to:

- exposed to specific potential vehicles
- whether ill or not

12. Control Measures

Central to any outbreak investigation is the timely implementation of appropriate control measures to minimize further illness and death. At best, the implementation of control measures would be guided by the results of the epidemiologic investigation and possibly (when appropriate) the testing of environmental specimens. However, this approach may delay prevention of further exposure to a suspected source of the outbreak and is, therefore, unacceptable from a public health perspective. The timing and nature of control measures are difficult to implement.

13. Interactions with the Public and Press

While the public and the press are not aware of most outbreak investigations, media attention and public concern become part of some investigations. Throughout the course of an outbreak investigation, the need to share information with public officials, the press, the public, and the population affected by the outbreak must be assessed.

Infodemics during disease outbreaks (Figure 13.4)[23, 24]

The information age has revolutionized healthcare, transforming the way we access and share information. Social media platforms have become double-edged swords. On the one hand, they empower public health initiatives by enabling the widespread dissemination of health messages and connecting individuals with valuable resources. This unprecedented access to information fosters health literacy, as vast amounts of evidence-based knowledge are now at our fingertips. Empowered individuals can take a more active role in managing their well-being. However, the abundance of information online can be overwhelming. Distinguishing credible sources from misleading or inaccurate information can be a challenge, especially during public health emergencies when fear and uncertainty are heightened. Misinformation spreads rapidly on social media, fueling panic and hindering effective public health responses, as seen during outbreaks like H1N1, Ebola, and Zika. To navigate this complex landscape and ensure optimal health outcomes, critical thinking skills are essential to assess the credibility of online information. By relying on trusted sources like public health organizations and reputable medical institutions, we can leverage the information age to empower individuals to make informed decisions about their health.

Social media has fueled unfounded fears and myths surrounding recent epidemics. The COVID-19 pandemic particularly highlights this issue. The sheer volume of unverified information, especially during times of social and health uncertainty, has hampered the search for effective solutions. Recognizing this,

national governments and international health organizations are prioritizing understanding the factors that drive these "infodemics" during outbreaks.

Infodemic management is a crucial response. It involves developing and implementing evidence-based strategies across various levels, all aimed at promoting positive behavioral changes in the population.

WHO outbreaks toolkit [25]

The Outbreak Toolkit (figure 13.5) project was launched in 2017 and is especially designed for complex emergencies and limited resource settings. It responds to the need for standardization of tools to improve comparability and sharing of data collected between investigation teams, locations, and time frames and hence contains guidelines, critical technical documents, tools, and

Figure 13.5 Instructions to use the Toolkit

resources needed to investigate and respond to outbreaks.

Objectives of the toolkit project:

1. Assist epidemiologists and investigators in the field to conduct detailed outbreak investigations by

- Minimising time spent prior to and during field deployment researching and locating key documents
- Arming staff with critical information needed to guide investigation design, data collection and response activities
- Improve awareness of existing resources available

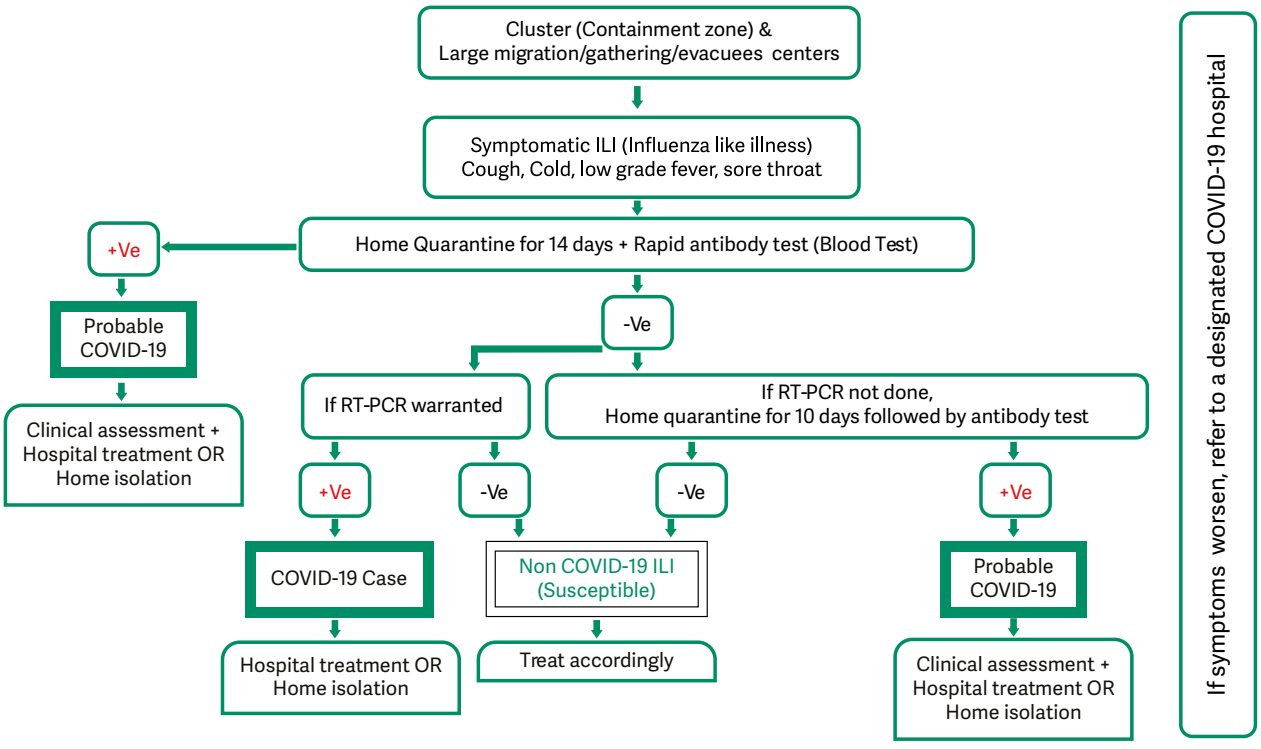
2. Support early evaluation of the cause, severity and risk of extension of the outbreak by

- Providing standardised tools for data collection
- Facilitating comparability and sharing of data during outbreak investigations
- Develop tools for the investigation of outbreak of unknown disease

A brief overview of COVID-19 outbreak management in India (Figure 13.6) [26, 27]

India, the world's seventh-largest nation by area and second-largest by population, identified its first COVID-19 case in Kerala during January 2020. The initial spread of the virus was rapid and geographically diverse across Indian states and territories. Notably, the causative agent of

Figure 13.6 **COVID-19 testing, diagnostic and treatment protocols released by Govt of India for suspected individuals**



this novel disease was initially unclear.

Challenges and Response Strategies:

The unprecedented nature of COVID-19 presented significant challenges. Mathematical models, crucial for understanding transmission dynamics in novel infectious diseases, played a vital role in estimating potential caseloads and the impact of implemented control measures.

Recognizing the gravity of the situation, the Indian government undertook several initiatives:

Diagnostic Infrastructure Expansion: The Indian Council of Medical Research (ICMR) established a network of 2,463 operational diagnostic laboratories (government and private) to enhance testing capacity.

Social Distancing Measures: Social distancing protocols were implemented to curb the potential for stage-3 human-to-human transmission and slow the spread of the virus.

Public Awareness Campaign: A nationwide 14-hour voluntary public curfew ("Janata Curfew") was imposed on March 22nd, 2020. This initiative aimed to raise public awareness about the unique epidemiological characteristics of COVID-19 compared to previous coronavirus outbreaks (SARS-CoV and MERS-CoV).

National Lockdown: To further restrict viral transmission, a 21-day nationwide lockdown was declared from March 25th, 2020, to April 14th, 2020, impacting India's vast population of 1.3 billion.

Healthcare System Augmentation: Recognizing the limitations of existing healthcare infrastructure, the government rapidly expanded capacity by converting railway coaches and medical colleges into isolation wards.

Lockdown Extension: In the absence of a readily available vaccine or specific therapeutic interventions, the lockdown was extended until May 3rd, 2020, to strengthen control measures against the pandemic.

The primary objective of these interventions was to limit social interactions in public spaces, including schools, colleges, theaters, and cultural events. Essential services like hospitals, pharmacies, police, and fire departments remained operational. The COVID-19 outbreak demonstrably altered daily life, public health, and the Indian economy in profound ways.

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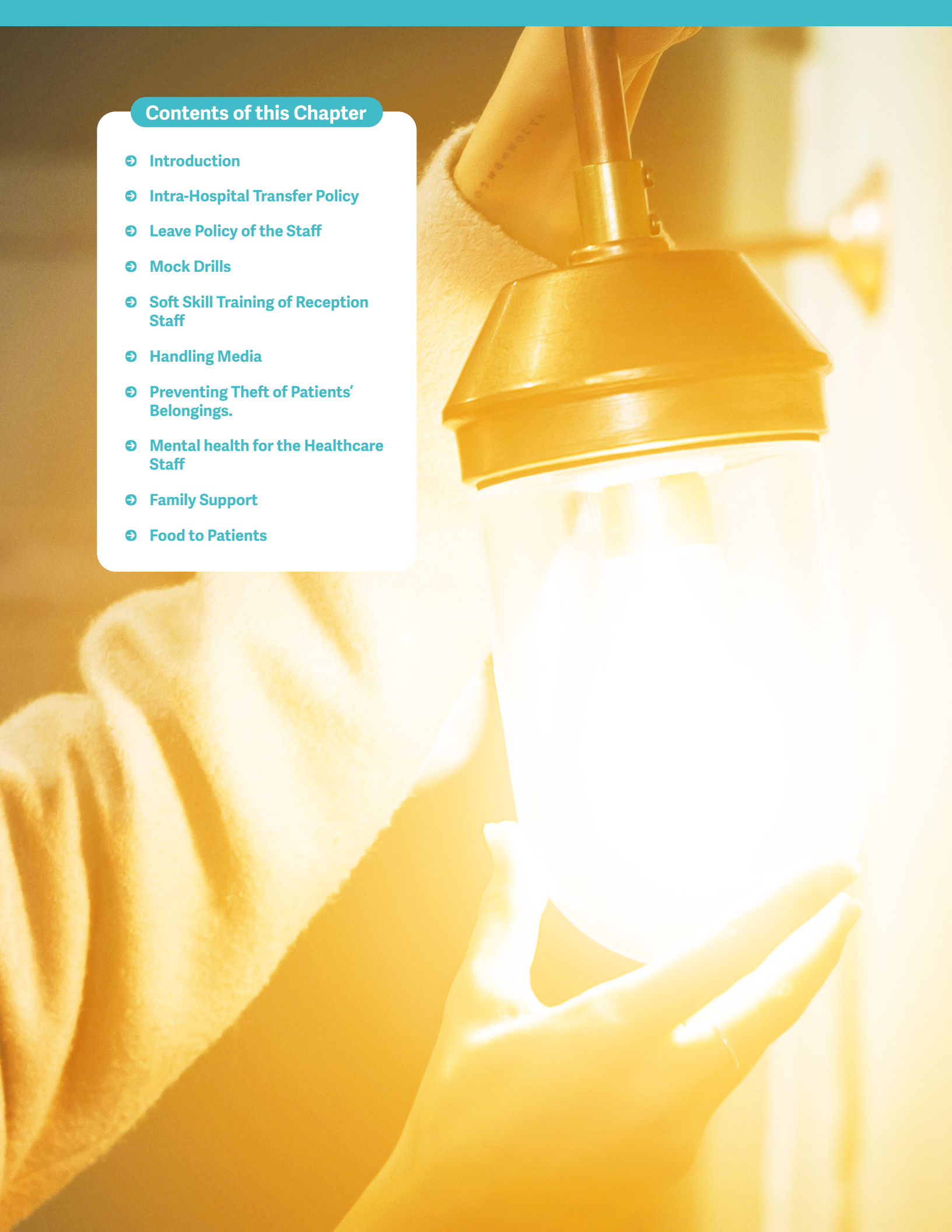

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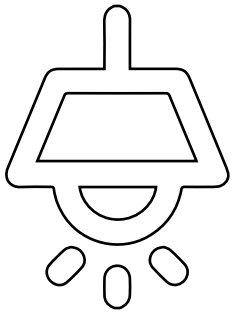
Chapter 14

Shedding Light on Less Explored Variables during Public Health Emergencies

Picture Credit: AIIMS, New Delhi

Shedding Light on Less Explored Variables during Public Health Emergencies



The COVID-19 pandemic had affected the entire world in unprecedented ways, and India was no exception. The virus had severely affected the nation, with numerous cases and fatalities being reported. To combat the spread of the virus and provide adequate care to those who are infected, it is essential that hospitals in India are properly prepared. This chapter explores the measures that have been taken in India to prepare for the COVID-19 pandemic, with a focus on the challenges that have been faced and the lessons that have been learnt. It also look at the ways in which hospitals can continue to improve their preparedness to provide the best possible care to patients during this difficult time.

Intra-hospital transfer policy

In view of curtailing the spread of infection, it is of paramount importance to keep the movement of the patient to a minimum. But sometimes it becomes essential to shift the patient from one location to another within the hospital. In pandemic situations, where patients are very infectious, the role of the intra-hospital transfer policy is significant . These policies outline the procedures and protocols for transferring patients within a hospital and are designed to ensure the safe and efficient movement of patients while minimising the risk of transmission of the virus. One important aspect of intra-hospital transfer policies is to establish clear criteria for when a patient should be transferred. This can include factors such as

- the severity of the patient's condition
- the availability of beds and resources
- the ability of different units of the hospital to provide the necessary level of care and
- sometimes the transfer is required for patient's investigations, dialysis etc.

Another important aspect is having clear protocols in place for the transfer of patients. This can include procedures for screening and testing patients before they are transferred, as well as guidelines for the use of personal protective equipment (PPE) during the transfer. This can include ensuring that the patients are properly isolated and that all staff handling them are wearing the appropriate PPE. It is also important to have a well-coordinated communication system in place between different units of the hospital and with other hospitals to ensure that the patient's medical history, current condition, and treatment plans are accurately and promptly shared. In addition, to achieve synergy and standardisation in infection prevention during transfer of patients, transfer should be created in conjunction with other procedural areas of the hospital.

Leave Policy of the staff

During a pandemic, such as COVID-19, hospitals need to have a well-defined leave policy in place to ensure that they have enough staff to provide care to patients. One important

aspect of a leave policy is to ensure that staff members can take time off if they are sick or need to care for a sick family member. This can include providing paid sick leave or allowing staff to use their accumulated vacation days or paid time off. Another important aspect of a leave policy is to ensure that staff members can take time off if they are experiencing stress or burnout because of their work during the pandemic. This can include providing paid leave for mental health or allowing staff to take a leave of absence if needed. It is also important for hospitals to have a policy in place for staff members who may need to quarantine or isolate due to exposure to infectious agent. This can include providing paid quarantine leave or allowing staff to work from home if possible. Furthermore, hospitals may also have to consider additional leave options for staff who are at higher risk for severe illness from the disease, such as pregnant or older staff.

Mock Drills

Mock drills are an important tool in the preparation for a public health emergency. They provide an opportunity for hospitals and other healthcare organisations to test and evaluate their readiness and response to a crisis. Mock drills can include simulations of a range of scenarios, such as a sudden influx of patients, the need for mass vaccination, or the activation of an emergency operations centre. These drills allow hospitals to test and evaluate their procedures, protocols, and systems and identify any areas that need improvement. During the mock drills, healthcare organisations can also test and evaluate their communication systems and procedures, ensuring that accurate and timely information is disseminated to all relevant parties, such as staff, patients, and the public. This is particularly important during a public health emergency, as accurate and timely information can help reduce confusion and anxiety. Mock drills also provide an opportunity for healthcare organisations to train and educate their staff on how to respond to a pandemic. This can include training on how to properly use personal protective equipment (PPE), how to triage and treat patients, and how to properly disinfect and decontaminate equipment and facilities. In addition to the above, mock drills also help to build resilience and adaptability in the healthcare system. It helps the healthcare organisations learn from their mistakes, identify the gaps, and make the necessary changes before the actual event.

Soft skill training of reception staff

Soft-skill training is an important aspect of emergency preparedness for the reception staff of hospitals. Reception staff are often the first point of contact for patients and visitors, and their behaviour and communication can greatly impact the overall experience of individuals entering the hospital. During a public health emergency, reception staff may have to deal with a high volume of patients, anxious family members, and a high level of stress. Soft-skills training can help them effectively communicate with patients and visitors, provide accurate information, and handle difficult situations in a calm and professional manner. Some examples of soft skills that can be trained include:

- Active listening and empathy: to understand the patient's needs and concerns
- Effective communication: to provide clear and accurate information
- Conflict resolution: to handle difficult situations with patients and visitors
- Time management and stress management: to deal with a high volume of patients and a high level of stress

In addition to soft skill training, training on how to properly use personal protective equipment (PPE), and how to properly disinfect and decontaminate equipment and facilities may also be instilled. This can help reception staff to provide safe and effective care while protecting themselves and others.

Handling Media and News

Media and news handling is an important aspect of a hospital's preparedness plan for public health emergencies. During a public health emergency, hospitals are often the primary source of information for the public, and it is important that they provide accurate and timely information to the media and the public. One important aspect of media and news handling is to have a designated spokesperson or communication team in place. This team should be responsible for communicating with the media and the public and should be trained on how to handle media inquiries and provide accurate and timely information. Another important aspect is having a ***Crisis Communication Plan*** in place. This plan should outline the steps that the hospital will take to communicate with the media and the public during a crisis, such as a pandemic. It should also include guidelines for the type of information that should be shared and how it should be shared. During a public health emergency, it is important for hospitals to provide regular updates on the number of cases, the status of patients, and any measures that are being taken to control the spread of the disease. It is also important to provide information on the hospital's response to the public health emergency, such as the number of beds available, the number of staff, and the availability of equipment and supplies. Hospitals should also be transparent and honest in their communication and avoid spreading misinformation, which can lead to panic and confusion.

Preventing Theft of patients' belongings.

During a pandemic such as COVID-19, preventing theft and misplacement of articles belonging to patients and the deceased is an important aspect of ensuring respectful and dignified care for the deceased and their families. One important step that hospitals can take is to establish clear policies and procedures for handling the personal belongings of the patients and deceased. This can include guidelines for identifying and labelling personal belongings, as well as procedures for securely storing and returning these belongings to the patient's family or next of kin. Another important step is to ensure that staff members who encounter the personal belongings of deceased patients are properly trained and understand the importance of treating these belongings with respect and care. This can include training on how to handle and store personal belongings, as well as how to communicate with the patient's family or next of kin. Hospitals should also have a system in place to track and document the movement of personal belongings of deceased patients to prevent misplacement. It is also important to have a protocol in place for dealing with missing or stolen items. This can include procedures for reporting and investigating incidents of theft or misplacement, as well as for providing compensation or reimbursement to the patient's family or next of kin if necessary.

Mental health of the healthcare staff

The COVID-19 pandemic has raised significant concerns about the mental health of healthcare workers. High levels of burnout, anxiety, and depression among healthcare workers are a result of the pandemic's ongoing stress and uncertainty, as well as the added workload and virus exposure risk. This may significantly affect both their capacity to offer patients high-quality care and their own general well-being. Healthcare organisations must place a high priority on the mental health of their employees by offering assistance and resources, such as counselling and mental health services, and by putting in place policies that support work-life balance and self-care.

Family support

The COVID-19 pandemic has placed a significant burden on healthcare workers, not only in terms of the physical and emotional demands of their job but also in terms of the impact on their families. Child and family support is crucial for healthcare workers during this time to help them manage the added stress and responsibilities

they are facing. Some ways to support healthcare workers and their families include:

- Providing affordable and accessible childcare options for healthcare workers with young children
- Offering flexible work arrangements, such as remote work or flexible scheduling, to allow healthcare workers to better manage their responsibilities at home
- Providing mental health support for healthcare workers and their families to help them cope with the added stress and anxiety of the pandemic
- Offering financial assistance to help healthcare workers and their families with expenses related to the pandemic, such as extra childcare costs or lost income

Food to patients

Providing proper food and ensuring balanced diet for patients is an important aspect of ensuring the health and well-being of patients during a public health emergency such as COVID-19. One important step that hospitals can take is to ensure that the food provided to patients is nutritious, safe, and appealing. This can include providing a variety of options to meet different dietary needs and preferences, as well as ensuring that the food is properly prepared and stored to prevent contamination. Another important step is to have a system in place for regularly monitoring the food intake of patients. This can include having staff members check in on patients to ensure that they are eating their meals and providing aid as needed. It can also include providing patients with the appropriate utensils, such as plates, cups, and cutlery, to ensure that they are able to eat their meals safely and comfortably. For those patients who are unable to eat due to various health conditions, the hospitals should have a plan in place for providing alternate forms of nutrition, such as tube feeding or intravenous nutrition. Hospitals should also have a protocol in place for dealing with patients who are refusing to eat or who have difficulty eating. This can include seeking the advice of a ditetician or other healthcare professional, providing emotional support, and counselling, and providing assistance with eating as needed.

Conclusion

This article summarises the challenges faced by the hospital administration during the COVID-19 pandemic. There are lots of lessons that this pandemic has taught mankind; this article covers a few of the ones we learned from our experience with the pandemic.

JOB AIDS FOR HEALTHCARE WORKERS

Infection Prevention & Control Practices and BioMedical Waste Management

A Guide to Handwashing with Soap and Water

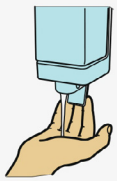
WASH HANDS WHEN VISIBLY SOILED
OTHERWISE, USE HANDRUB

Duration of the entire process: 40-60 seconds

0

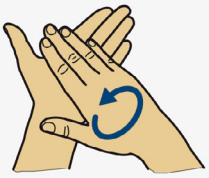
Wet hands with water

1



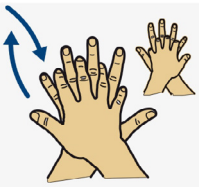
Apply enough soap to cover all hand surfaces

2



Rub hands palm to palm

3

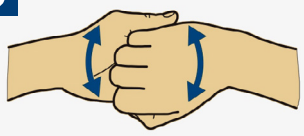


Right palm over left dorsum with interlaced fingers & vice versa

4

Palm to palm with fingers interlaced

5

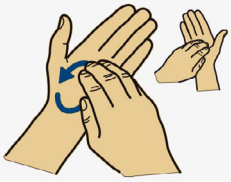


Backs of fingers to opposing palms with fingers interlocked

6

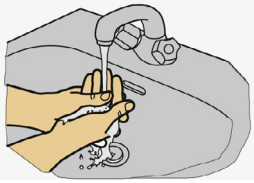
Rotational rubbing of left thumb clasped in right palm and vice versa

7



Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa

8

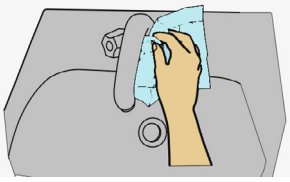


Rinse hands with water

9

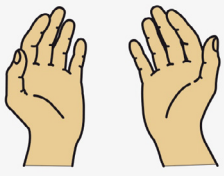
Dry hands thoroughly with a single use towel

10



Use towel to turn off faucet

11



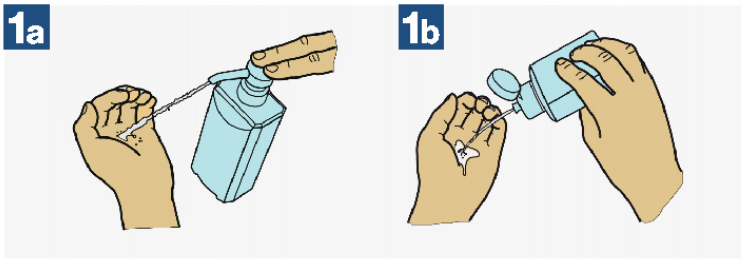
Your hands are now safe

Source: WHO (https://www.who.int/docs/default-source/patient-safety/how-to-handwash-poster.pdf?sfvrsn=7004a09d_2)

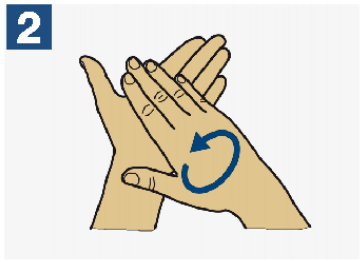
A Guide to use Alcohol Based Handrub

RUB HANDS FOR HAND HYGIENE!
WASH HANDS WHEN VISIBLY SOILED.

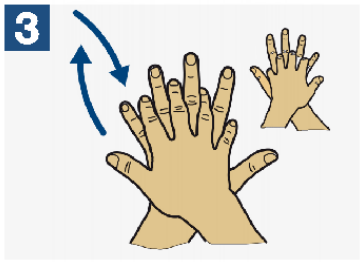
Duration of the entire procedure: 20-30 seconds



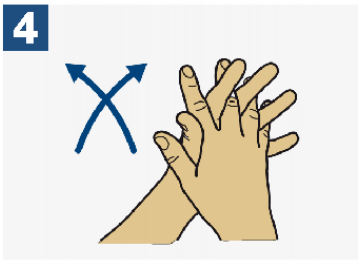
Apply a palmful of the product in a cupped hand, covering all surfaces



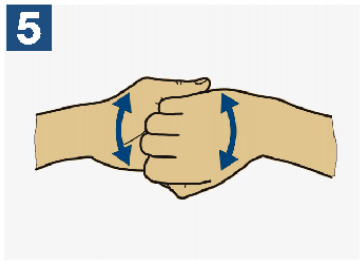
Rub hands palm to palm



Right palm over left dorsum with interlaced fingers & vice versa

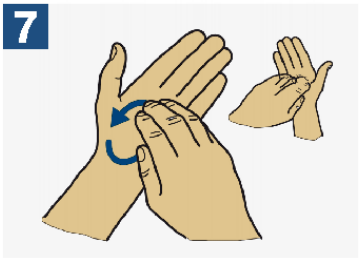


Palm to palm with fingers interlaced

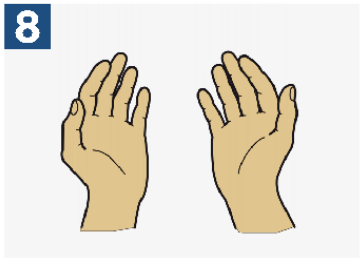


Backs of fingers to opposing palms with fingers interlocked

Rotational rubbing of left thumb clasped in right palm and vice versa



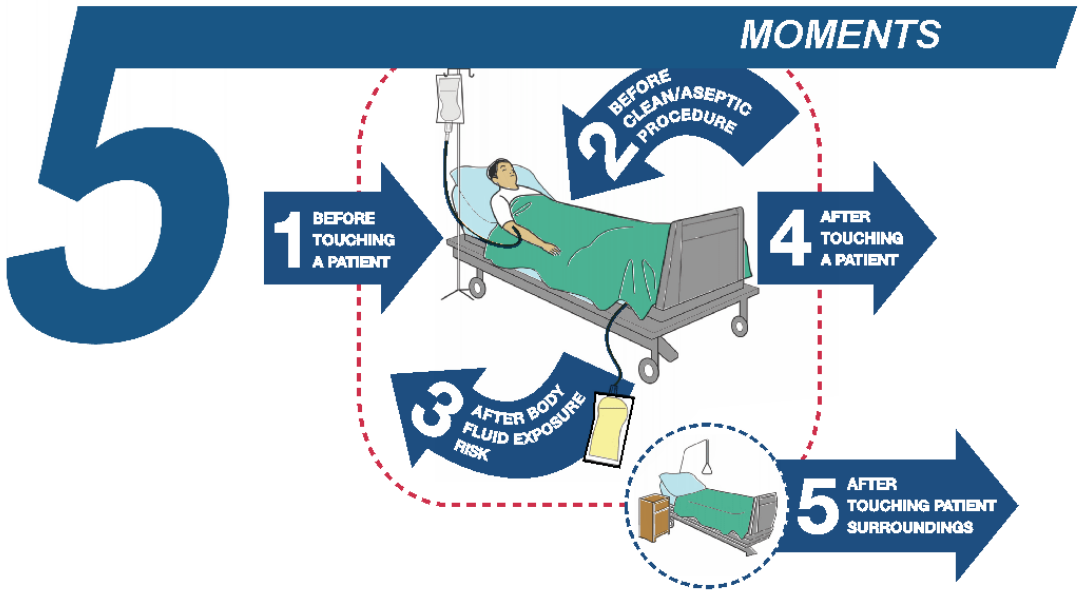
Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa



Once dry, your hands are safe

Source: WHO (https://cdn.who.int/media/docs/default-source/patient-safety/how-to-handrub-poster.pdf?sfvrsn=9d2f6e89_11)

FIVE MOMENTS FOR HAND HYGIENE



1	BEFORE TOUCHING A PATIENT	**When?** Clean your hands before touching a patient. **Why?** To protect the patient against harmful germs carried on your hands.
2	BEFORE CLEAN/ASEPTIC PROCEDURES	**When?** Clean your hands immediately before performing a clean/aseptic procedure. **Why?** To protect the patient against harmful germs, including the patient's own, from entering his/her body.
3	AFTER BODY FLUID EXPOSURE RISK	**When?** Clean your hands immediately after a procedure involving exposure risk to body fluids (& after glove removal). **Why?** To protect yourself & the environment from harmful patient germs.
4	AFTER TOUCHING A PATIENT	**When?** Clean your hands after touching the patient at the end of the encounter or when the encounter is interrupted. **Why?** To protect yourself & the environment from harmful patient germs.
5	AFTER TOUCHING PATIENT SURROUNDINGS	**When?** Clean your hands after touching any object or furniture in the patient surroundings when a specific zone is temporarily & exclusively dedicated to a patient- even if the patient has not been touched. **Why?** To protect yourself & the environment from harmful patient germs.

Source: WHO (https://cdn.who.int/media/docs/default-source/integrated-health-services-(ihs)/infection-prevention-and-control/your-5-moments-for-hand-hygiene-poster.pdf?sfvrsn=83e2fb0e_6)

SURGICAL HAND RUB

The handrubbing technique for surgical hand preparation must be performed on perfectly clean, dry hands.
On arrival in the operating theatre and after having donned theatre clothing (cap/hat/bonnet and mask), hands must be washed with soap and water.
After the operation when removing gloves, hands must be rubbed with an alcohol-based formulation or washed with soap and water if any residual talc or biological fluids are present (e.g. the glove is punctured).

Surgical procedures may be carried out one after the other without the need for handwashing, provided that the handrubbing technique for surgical hand preparation is followed (Images 1 to 17).

1

Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the dispenser

2

Dip the fingertips of your right hand in the handrub to decontaminate under the nails (5 seconds)

3

Images 3–7: Smear the handrub on the right forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds)

4

See legend for Image 3

5

See legend for Image 3

6

See legend for Image 3

7

See legend for Image 3

8

Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your right hand, using the elbow of your other arm to operate the dispenser

9

Dip the fingertips of your left hand in the handrub to decontaminate under the nails (5 seconds)

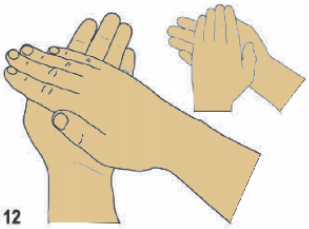
SURGICAL HAND RUB

10

Smear the handrub on the left forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds)

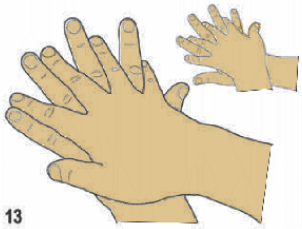
11

Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the distributor. Rub both hands at the same time up to the wrists, and ensure that all the steps represented in Images 12-17 are followed (20-30 seconds)



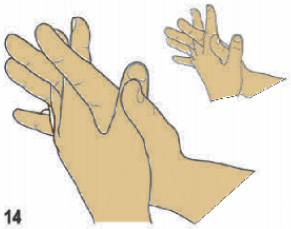
12

Cover the whole surface of the hands up to the wrist with alcohol-based handrub, rubbing palm against palm with a rotating movement



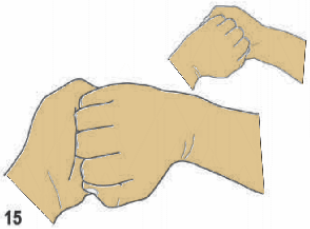
13

Rub the back of the left hand, including the wrist, moving the right palm back and forth, and vice-versa



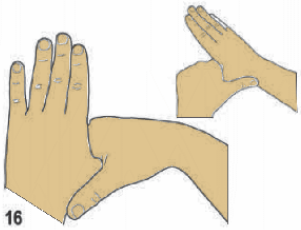
14

Rub palm against palm back and forth with fingers interlinked



15

Rub the back of the fingers by holding them in the palm of the other hand with a sideways back and forth movement



16

Rub the thumb of the left hand by rotating it in the clasped palm of the right hand and vice versa

17

When the hands are dry, sterile surgical clothing and gloves can be donned

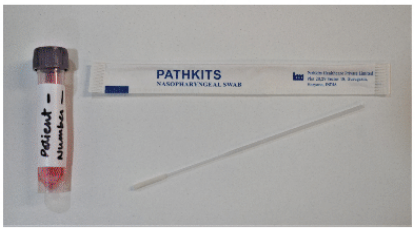
Repeat the above-illustrated sequence (average duration, 60 sec) according to the number of times corresponding to the total duration recommended by the manufacturer for surgical hand preparation with an alcohol-based handrub.

Source: WHO

REQUIRED ITEMS FOR COLLECTING INFECTIOUS OROPHARYNGEAL/ NASOPHARYNGEAL SAMPLES

Required Items

Viral Transport Media



Swab Sticks

Ice box/vaccine carrier

Ice packs/Gel packs

Tongue Depressor

Permanent Marker

Requisition form

PPE (Personal Protective Equipment)

Credits: AIIMS, New Delhi

PROCEDURE FOR NASOPHARYNGEAL/ OROPHARYNGEAL SAMPLE COLLECTION FOR COVID-19

Credits: AIIMS, New Delhi

TRANSPORTATION OF INFECTIOUS SPECIMEN

The specimen should be transferred to the laboratory maintaining the cold chain at 2-4°C

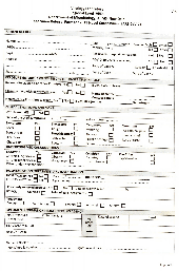
+2 to +4°C

If there is delay of more than 72 hours, sample should be stored at -70°C

>72 hours delay

Store at -70°C.

Specimen data forms, letters, and other types of information that identify or describe the specimen for testing of SARS-COV-2 should be carried



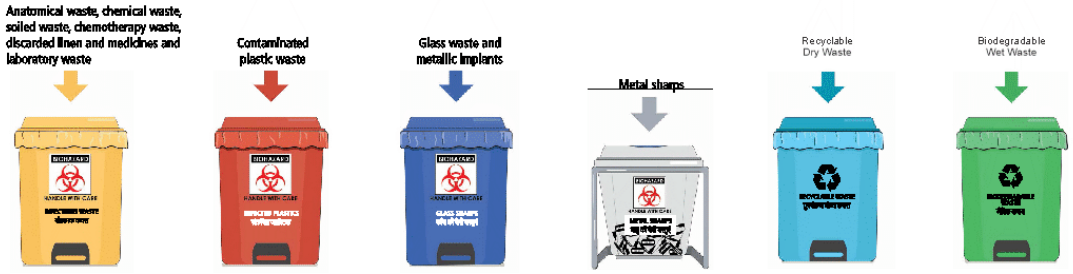
Clean the icebox thoroughly from the outside with 1% Sodium Hypochlorite and transfer the specimen to the lab

Credits: AIIMS, New Delhi

BIOMEDICAL WASTE MANAGEMENT (BMW) HANDLING PROCEDURE

Segregation

BMW should be segregated at the point of generation, using color-coded bins or bags according to the type of waste.

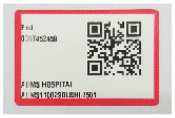


Collection

BMW containers should be closed and handled carefully to avoid spillage/breakage and transported from the point of generation to the designated storage area using leakproof trolleys or carts.

Transportation

The segregated BMW should be collected in puncture-resistant and leak-proof containers, with appropriate labels and markings to identify the type of waste, quantity, and date of disposal.



Details included in the Barcode
- Time
- Date
- Quantity
- Colour coding

Storage

Segregate and keep the labeled biomedical waste bins closed and in a secure, well-ventilated area with fire extinguishers with access to authorized personnel only

Treatment and Disposal

As per Central Pollution Control board /local regulations Disposal should be done with consideration to minimizing risk of exposure to healthcare workers, public, and the environment.

Documentation

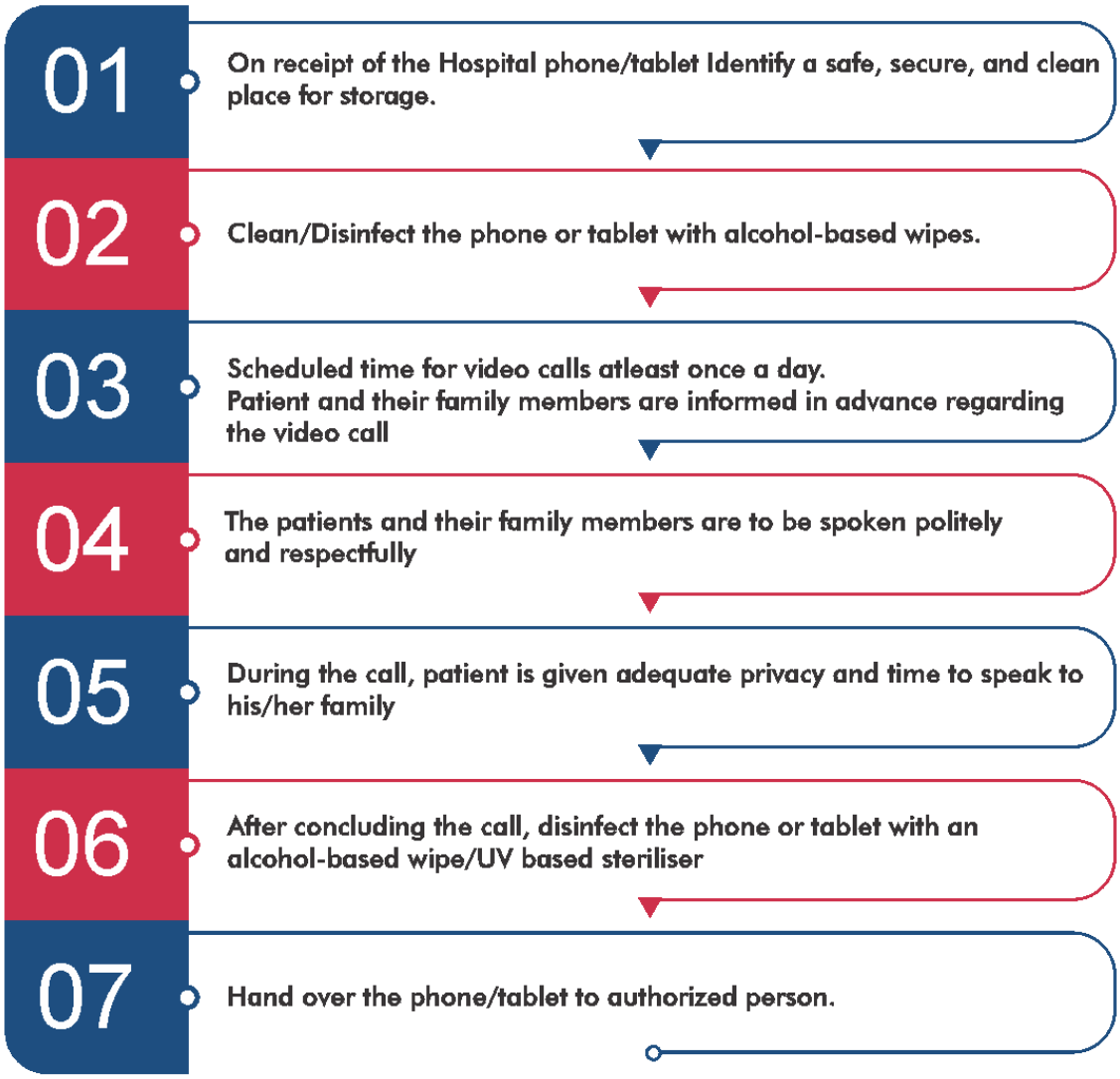
A record of BMW should be maintained and retained for a period of time according to local regulations: type, quantity of waste generated, collected, transported, treated, and disposed

Adapted from Bio Medical Waste Management Rules 2016 , CPCB

COMMUNICATING VIRTUALLY WITH THE PATIENTS' FAMILY MEMBERS

Virtual Visiting: Utilization of a shared hospital phone to make video calls arranged by a designated hospital staff with the patient's family members.

Procedure to be followed



Credits: AIIMS, New Delhi

HOUSEKEEPING AND DISINFECTION ROUTINE

The frequency of cleaning/disinfection may vary according to the risk categories

Floors, Cubicles, Sluice Room, Pantry and Toilet/Bathroom

Clean
With Detergent + water

DONTS
- X Sweep
- X Do not use glutaraldehyde

Frequency
Every day; In all 3 shifts

Walls

Clean
With water and detergent (Soap Solution)

Other considerations
If soiled or stained

Frequency
Once a week

Fans

Clean
With wet Mop with water

Frequency
Once in two weeks

Air Conditioners

Clean
By Vacuum Cleaning

Other considerations
Before restarting A/C after a long period of non-use, call plant technician for cleaning.

Frequency
Window A/C: Once a week
Split A/C: Once in two weeks

Glass

Clean
With glass cleaning solution

Other considerations
Whenever needed

Frequency
Once a week

Refrigerators

Clean
Defrost and clean with soap solution

Frequency
Once in a week

Sinks and washbasins

Clean
With cleaning solution (e.g. Soap/Detergent)

Other considerations
Whenever necessary

Frequency
Atleast daily and as & when required. Ideally in each shift. (e.g. Soap/Detergent)

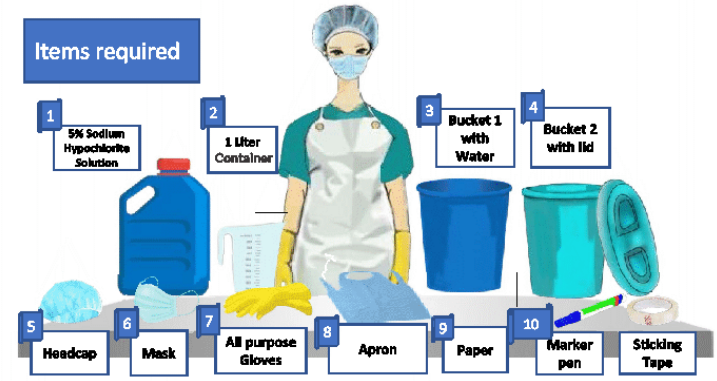
Buckets

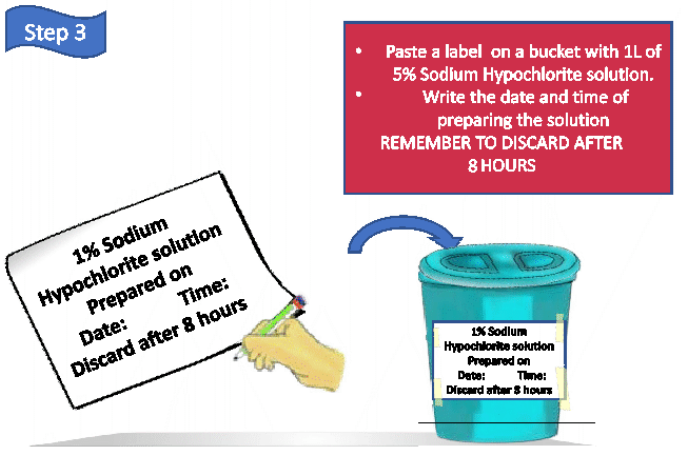
Clean
With soap and water

Frequency
Daily: morning shift, after picking up BMW bags.
Thorough cleaning once a week

Other considerations
Dry after cleaning and put respective color coded polythene bags

STEPS OF MAKING 1% SODIUM HYPOCHLORITE SOLUTION



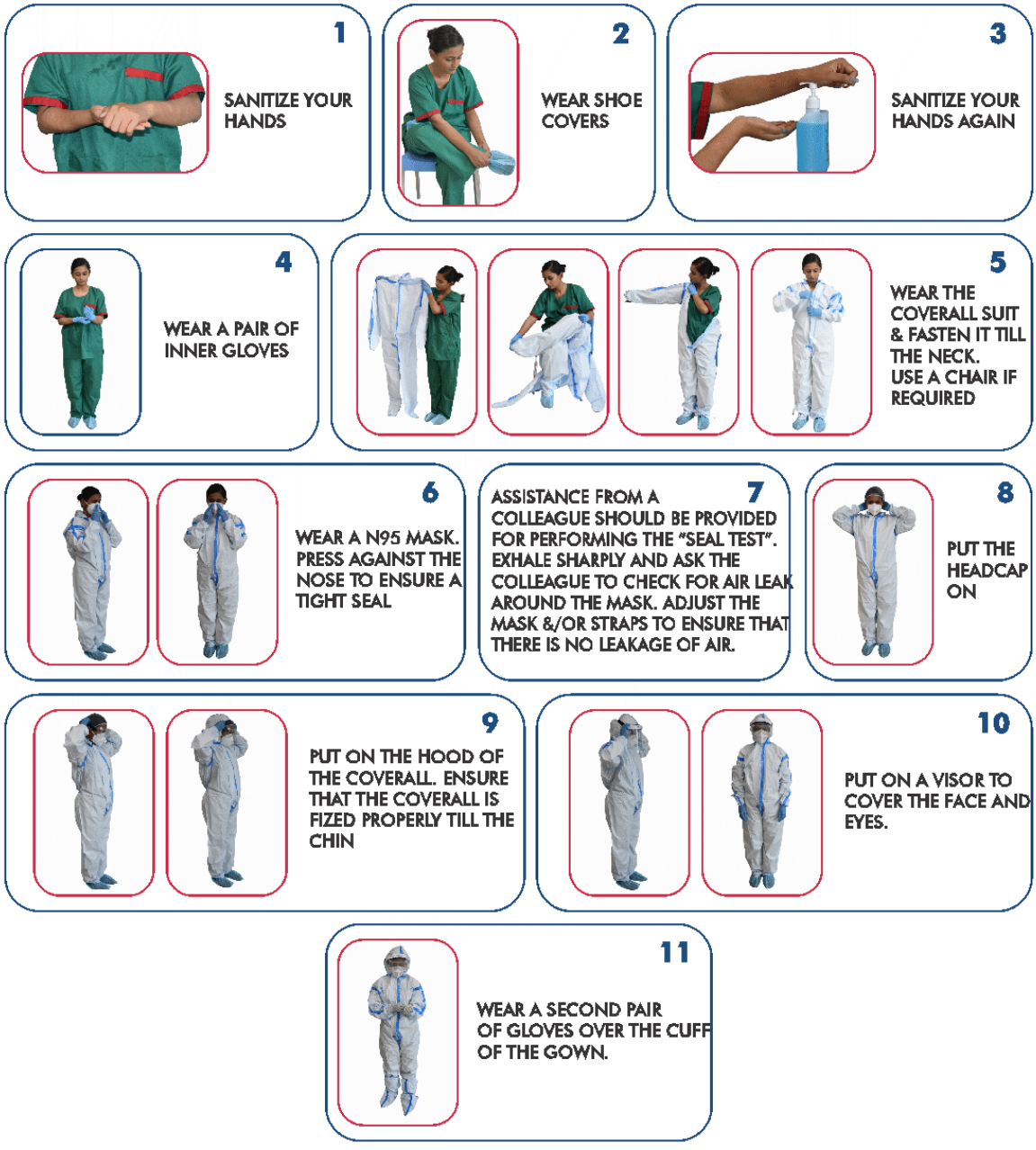


Credits: Dept. of Microbiology, AIIMS, New Delhi

PERSONAL PROTECTIVE EQUIPMENT FOR WASTE HANDLERS

Credits: AIIMS, New Delhi

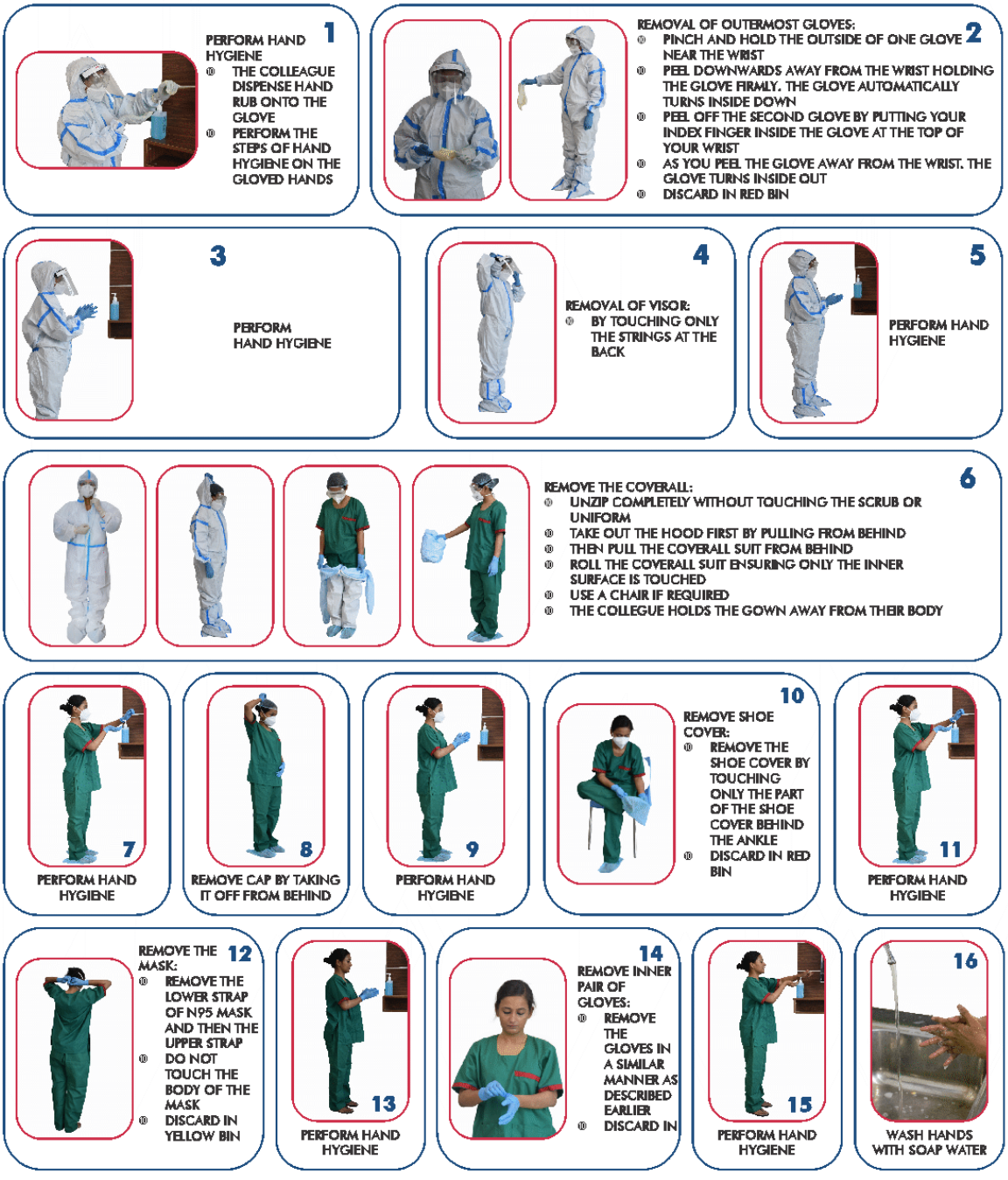
DONNING THE PPE



*THE OBSERVER WILL PERFORM A FINAL CHECK BEFORE THE PERSON ENTERS THE PATIENT CARE AREA

Credits: AIIMS, New Delhi

DOFFING THE PPE

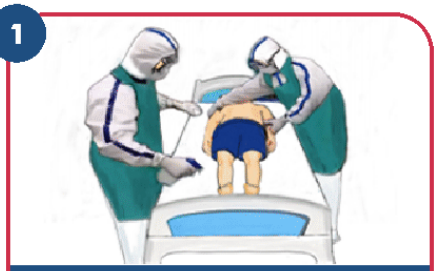


Credits: AIIMS, New Delhi

MANAGEMENT OF THE DECEASED

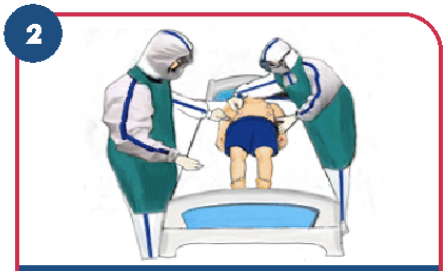
A minimum of people clad in PPE are required to perform the 10 steps to pack the deceased person

1



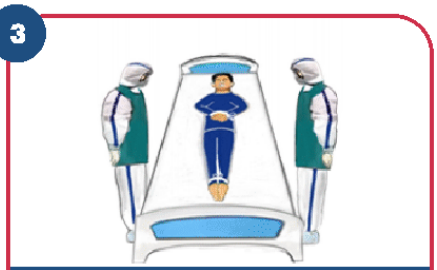
Spray 1% Sodium Hypochlorite solution and wipe the body

2



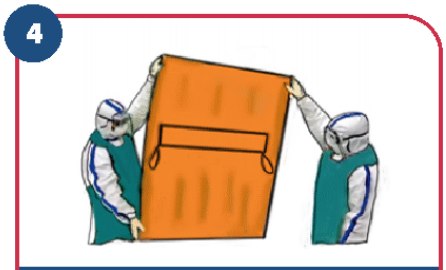
Remove all the tubes from the body

3



Close all the orifices (put cotton in the nostrils mouth and ears) Tie the hands and legs

4

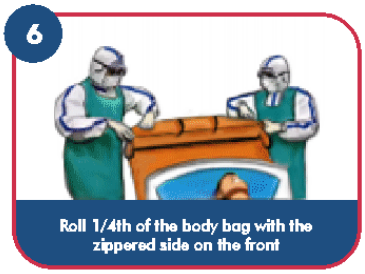


Take a leak proof body bag and straighten it out

5

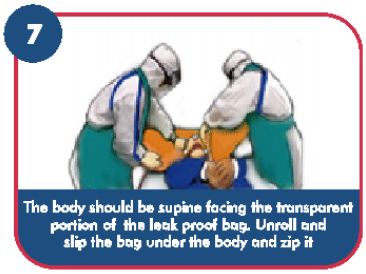
Unzip the leak-proof bag

6



Roll 1/4th of the body bag with the zippered side on the front

7



The body should be supine facing the transparent portion of the leak proof bag. Unroll and slip the bag under the body and zip it

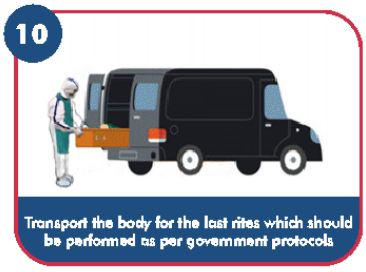
8

Once again, spray the body with 1% Sodium Hypochlorite solution

9

Paste a label with details with name of the patient and date of demise

10



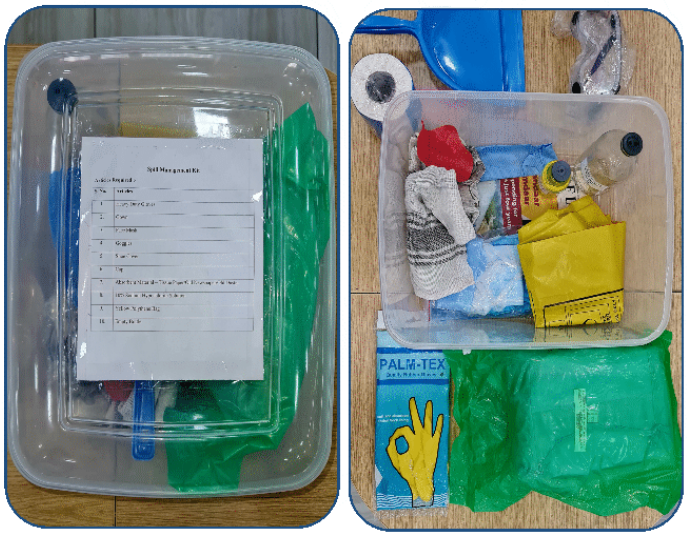
Transport the body for the last rites which should be performed as per government protocols

Credits: Dept. of Forensic Medicine, AIIMS, New Delhi

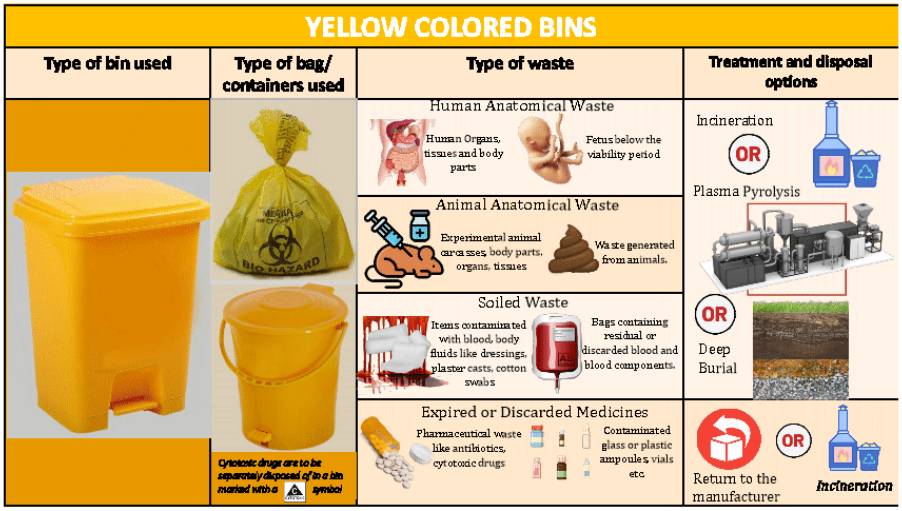
SPILL MANAGEMENT

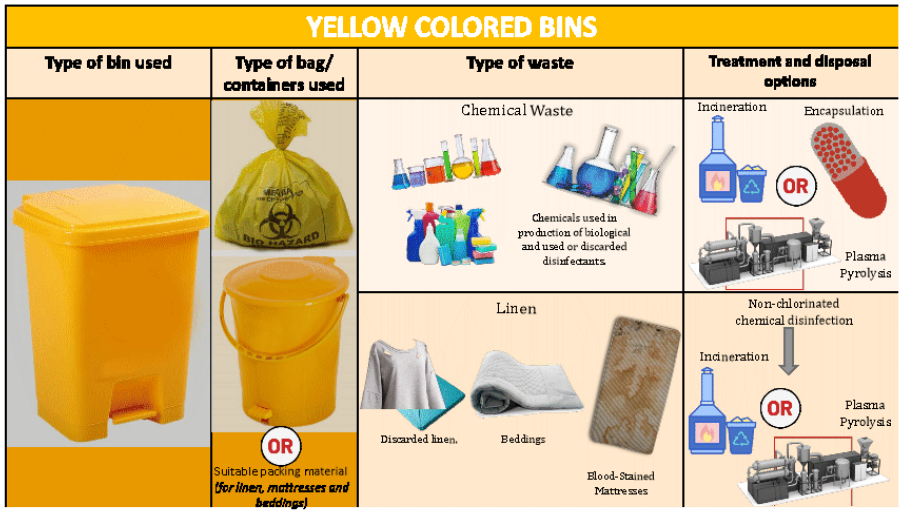
General recommendations for cleaning blood spills:

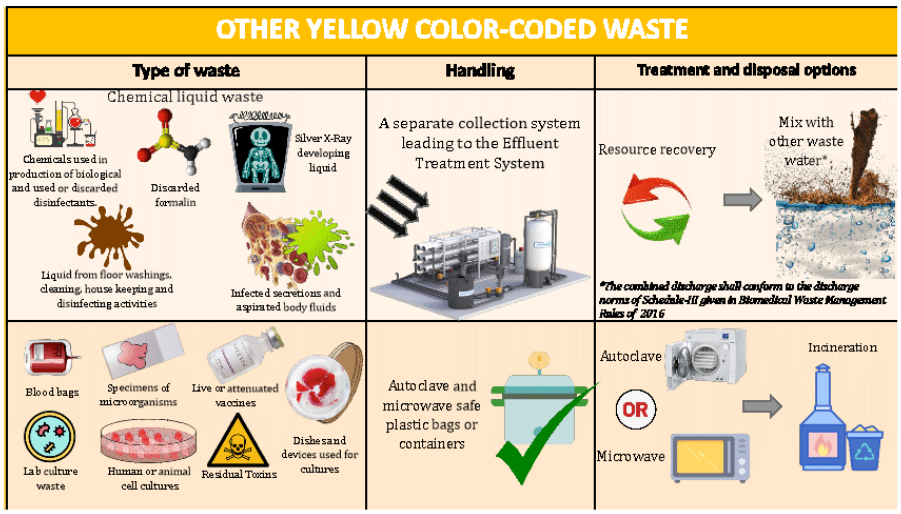
1. Isolate the spill area
2. Appropriate personal equipment (PPE) like gowns or aprons, boots, and protective shoe covers should be worn for cleaning up a blood spill
3. Heavy-duty gloves should be worn during cleaning and disinfecting procedures
4. PPE should be changed if torn or soiled and always removed before leaving the location of a spill after washing hand
5. Discard the broken glass in a white cardboard box with a blue lining (e.g. blood culture bottles, specimen vials, etc)
6. Cover the area immediately with any absorbent material like tissue paper, old newspaper, or old dusters remove obvious organic matter, and discard it in a yellow plastic bag
7. After removing organic matter, the area should be spread with absorbable material such as paper or cloth and freshly prepared 1% hypochlorite solution should be poured in a circular motion from the periphery to the center over the spread in an adequate quantity and left it for 10-15 minutes. Then wipe and discard the material in a yellow plastic bag.
8. The treated area should be cleaned with floor disinfectant and allowed to dry
9. Remove PPE and discard
10. Wash hands with soap and water
11. Record the incident in the incident report

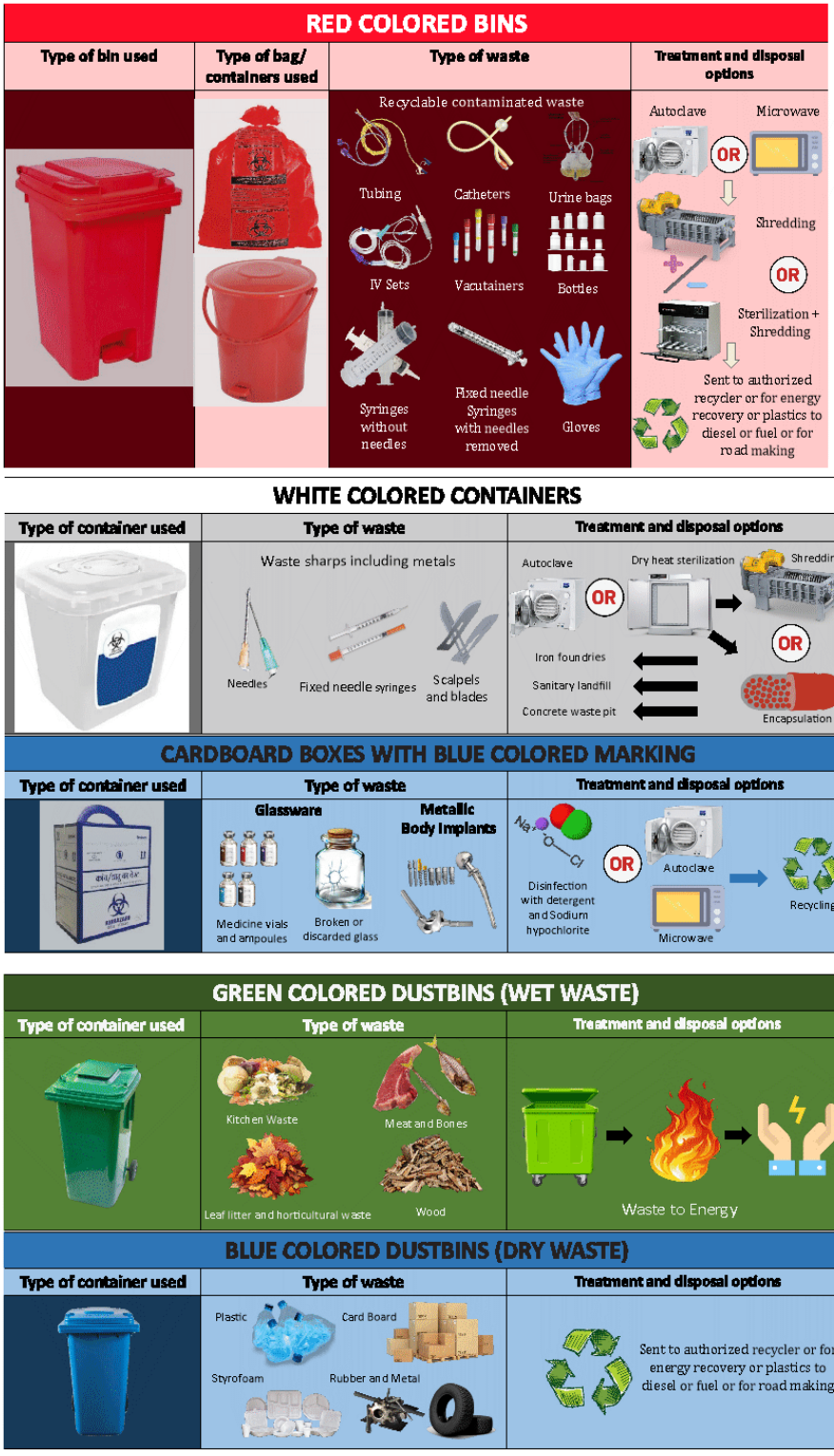


Credits: HICC, AIIMS, New Delhi


YELLOW COLORED BINS
Type of bin used
Type of bag/ containers used
Type of waste
Treatment and disposal options
Human Anatomical Waste
Human Organs, tissues and body parts
Fetus below the viability period
Animal Anatomical Waste
Experimental animal carcasses, body parts, organs, tissues
Waste generated from animals.
Soiled Waste
Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs
Bags containing residual or discarded blood and blood components.
Expired or Discarded Medicines
Pharmaceutical waste like antibiotics, cytotoxic drugs
Contaminated glass or plastic ampoules, vials etc.
Incineration
OR
Plasma Pyrolysis
OR
Deep Burial
Return to the manufacturer
OR
Incineration
Cytotoxic drugs are to be separately disposed of in a bin marked with a symbol


YELLOW COLORED BINS
Type of bin used
Type of bag/ containers used
Type of waste
Treatment and disposal options
Chemical Waste
Chemicals used in production of biological and used or discarded disinfectants
Incineration
Encapsulation
OR
Plasma Pyrolysis
Linen
Discarded linen.
Beddings
Blood-Stained Mattresses
Non-chlorinated chemical disinfection
Incineration
OR
Plasma Pyrolysis
OR
Suitable packing material (for linen, mattresses and beddings)


OTHER YELLOW COLOR-CODED WASTE
Type of waste
Handling
Treatment and disposal options
Chemical liquid waste
Chemicals used in production of biological and used or discarded disinfectants.
Discarded formalin
Silver X-Ray developing liquid
Liquid from floor washings, cleaning, house keeping and disinfecting activities
Infected secretions and aspirated body fluids
A separate collection system leading to the Effluent Treatment System
Resource recovery
Mix with other waste water*
*The combined discharge shall conform to the discharge norms of Schedule-II given in Biomedical Waste Management Rules of 2016
Blood bags
Specimens of micro organisms
Live or attenuated vaccines
Lab culture waste
Human or animal cell cultures
Residual Toxins
Dishes and devices used for cultures
Autoclave and microwave safe plastic bags or containers
Autoclave
OR
Microwave
Incineration


RED COLORED BINS
Type of bin used
Type of bag/ containers used
Type of waste
Treatment and disposal options
Recyclable contaminated waste
Tubing
Catheters
Urine bags
IV Sets
Vacutainers
Bottles
Syringes without needles
Fixed needle Syringes with needles removed
Gloves
Autoclave
Microwave
OR
Shredding
OR
Sterilization + Shredding
Sent to authorized recycler or for energy recovery or plastics to diesel or fuel or for road making
WHITE COLORED CONTAINERS
Type of container used
Type of waste
Treatment and disposal options
Waste sharps including metals
Needles
Fixed needle syringes
Scalpels and blades
Autoclave
Dry heat sterilization
Shredding
OR
OR
Iron foundries
Sanitary landfill
Concrete waste pit
Encapsulation
CARDBOARD BOXES WITH BLUE COLORED MARKING
Type of container used
Type of waste
Treatment and disposal options
Glassware
Metallic Body Implants
Medicine vials and ampoules
Broken or discarded glass
Disinfection with detergent and Sodium hypochlorite
OR
Autoclave
Microwave
Recycling
GREEN COLORED DUSTBINS (WET WASTE)
Type of container used
Type of waste
Treatment and disposal options
Kitchen Waste
Meat and Bones
Leaf litter and horticultural waste
Wood
Waste to Energy
BLUE COLORED DUSTBINS (DRY WASTE)
Type of container used
Type of waste
Treatment and disposal options
Plastic
Card Board
Styrofoam
Rubber and Metal
Sent to authorized recycler or for energy recovery or plastics to diesel or fuel or for road making

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